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Lower Yellowstone River Irrigation Dam, Fish Protection and Passage

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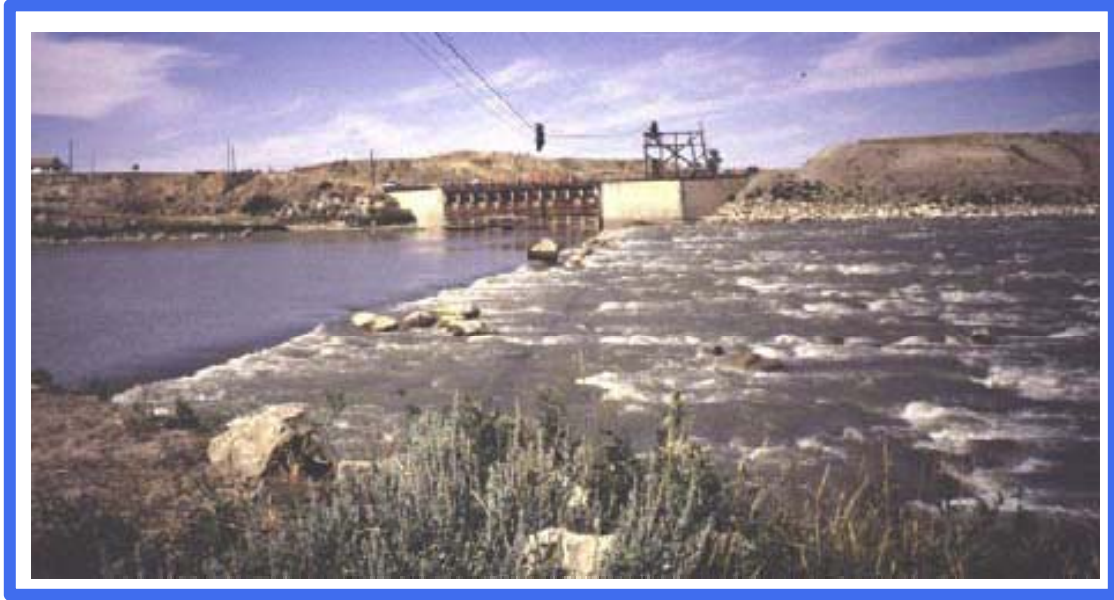
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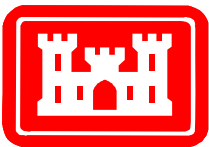
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Value Engineering Report



Lower Yellowstone River Irrigation Dam, Fish Protection and Passage

June 2009



**U. S. Army
Corps of Engineers**



***Conducted by
GeoVal, Inc.***



June 10, 2009

U.S. Army Corps of Engineers Hurricane Protection Office
Omaha District
1616 Capitol Ave.
Omaha, Nebraska 68102-9000

ATTN: Richard Stricker, PE, Value Engineering Officer

Reference: Value Engineering Study Report
Lower Yellowstone River Irrigation Diversion Dam, Fish Protection
and Passage

Dear Mr. Stricker:

I am pleased to submit electronic copy of the Value Engineering Report for the above-referenced project, transmitted to your FTP site.

I enjoyed working with you and the team on this important project and hope that the findings of this report will be of benefit to the U.S. Army Corps of Engineers as the agency moves forward with a decision as to the best alternative(s) that will focus on the creation of shallow water habitats as part of the Lower Yellowstone River Irrigation Diversion Dam, Fish Protection and Passage Project.

If you have any questions or comments regarding the study, please call me at (858) 484-6498.

Sincerely,

GeoVal, Inc.

A handwritten signature in black ink, appearing to read "Ronald J. Tanenbaum", with a long, sweeping horizontal line extending to the right.

Ronald J. Tanenbaum, CVS, PhD, PE, GE, F.ASCE
President

TABLE OF CONTENTS

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Introduction.....	..ii
Summary of Findings.....	..ii
Project Description	iv
Assumed Baseline Design	v
Cost Assessment.....	vi
Project Analysis	vi
VE Alternatives	vii
VE Team and Process.....	ix

VALUE ENGINEERING ALTERNATIVES

Evaluation Process.....	1
VE Alternative Content and Special Notes	2

VALUE ENGINEERING COMMENTS

Introduction.....	84
Design Comments	84

VALUE ENGINEERING PROCESS

General.....	101
Pre-Study Preparation	101
VE Study.....	103
VE Study Workshop Agenda	106

APPENDICES

A. Project Description, Project Critical Issues, Constraints, and Performance Attributes.....	A-1
B. VE Cost Assumptions	B-1
C. Function Analysis System Technique (FAST) Diagram	C-1
D. Speculation List	D-1
E. Contact Directory and Attendance.....	E-1

EXECUTIVE SUMMARY

INTRODUCTION

This Value Engineering (VE) Report summarizes the events of the VE workshop facilitated by GeoVal, Inc., June 1-5, 2009 for the U.S. Army Corps of Engineers (USACE) Omaha District, Nebraska. The Lower Yellowstone River Irrigation Dam, Fish Protection and Passage Value Engineering Study focuses on the assessment of alternatives for meeting Federal project objectives examining current plans and programs to seek out alternative approaches and ideas that will improve the overall performance of the project.

Federal project objectives of the Lower Yellowstone River Irrigation Dam, Fish Protection and Passage Project are to:

- Continue to provide reliable irrigation water delivery to the Irrigation Districts;
- Comply with the Endangered Species Act (ESA) by maximizing the opportunity for fish species to freely migrate up and down the Yellowstone River, and preventing entrainment of the fish within the irrigation canal; and
- Conduct the project with full transparency, and in collaboration with all Federal, State and local stakeholders.

The purpose of the VE study is to identify potential viable alternatives to improve the overall performance and cost of the Lower Yellowstone River Irrigation Dam, Fish Protection and Passage Project. Such improvements generally look to improving function, improving quality, and reducing and/or increasing cost/performance as appropriate to improve the project value.

SUMMARY OF FINDINGS

Outlined below is a summary of the significant findings of the VE team with regard to alternatives that offer the most potential of meeting program objectives:

- An approximate 1% slope rock ramp is deemed the most appropriate alternative for accomplishing the project objectives, purpose and need, assuming that currently underway modeling proves this to be the case. This slope will likely consist of a compound structure that is flatter adjacent to the dam and steeper at the toe of the ramp, velocities permitting.

- The ramp should be constructed in a layered fashion utilizing varying grades of fill material, including, random soil, fieldstone, etc., with natural quarry rock on the surface rather than constructing the ramp completely out of quarry stone.
- There appears to be some potential for constructing the lower portion of the ramp in the wet. The final project would be completed in the dry, with reduced diversion of water, to achieve the final project specifications while maintaining the desired fish performance criteria.
- Ensure that the low flow channel in the rock ramp ties in with the natural thalweg at the toe of the dam as the pallid sturgeon typically follow the thalweg during their migration in the river.
- The number/capacity of the fish screens should be increased to provide sufficient redundancy to allow as-needed maintenance while still having the ability to provide the maximum 1,400 cubic feet per second (cfs) flow to the irrigation canal.
- The Project Development Team (PDT) is currently focusing on the use of removable, submerged, rotating cylindrical screens, each capable of passing 100 cfs, located at the entrance to the irrigation canal. It is not clear at this time that these are the most appropriate screen for this project. Other fish screen types and providers are available that may be suitable for this project. The PDT is encouraged to consult with experts in the Walla Walla District of the USACE regarding the determination of the most suitable screening system and the available sources.
- The USACE should explore stockpiling extra rock at the site for future maintenance so that emergency work will not be delayed waiting for suitable materials to be delivered from off-site.
- The USACE should continue to explore multiple sources of suitable quality and quantity of quarry and field stone, as multiple sources may be required.
- In order to assure meeting milestone dates on the schedule as well as obtain long-lead items and adequate supplies of quarry stone, the USACE should explore the use of purchase-ordering screens and rock and specifying these materials as government-supplied materials, when the project construction contract is awarded.

PROJECT DESCRIPTION

The U. S. Fish and Wildlife Service (Service) listed the pallid sturgeon (*Scaphirhynchus albus*) as endangered under the Endangered Species Act (ESA) in 1990. The Lower Yellowstone River is part of the historic habitat range for pallid sturgeon and many other native warm water fish species (e.g. paddlefish, blue sucker, burbot, etc...). The lower Yellowstone River has been identified by the Service as one of the best opportunities for recovery of pallid sturgeon, because sturgeon are still in the area, and there is suitable habitat in the river for restoration and recovery.

Construction of the Lower Yellowstone Project began in 1905 and included Intake Diversion Dam - a 12-foot high wood and stone structure that spans the Yellowstone River and raises the water level for the diversion. Intake Diversion Dam likely has impeded upstream migration of pallid sturgeon and other native fish for more than 100 years. The best available science suggests that the diversion dam is a partial barrier to some species and is likely a total barrier to other species, such as pallid sturgeon, due to impassable turbulence and velocities associated with the rocks at the dam and downstream. In addition, entrainment studies in the late 1990's indicated that the diversion structure traps numerous fish in the canal system due to the lack of any screens on the gates.

Regulatory environmental agencies (U.S. Fish and Wildlife Service and State of Montana Department of Fish, Wildlife and Parks) have been actively pursuing resolution of the fish passage and entrainment issues with the Bureau of Reclamation. Resolution of these issues would minimize entrainment in the canal and provide open access for migration to another 165 river miles of habitat including the confluences of two major tributaries (Powder River and Tongue River).

The general study area is shown in **Figure 1**.

Montana Greater Yellowstone Watersheds

Showing Cities, Counties, & Streams

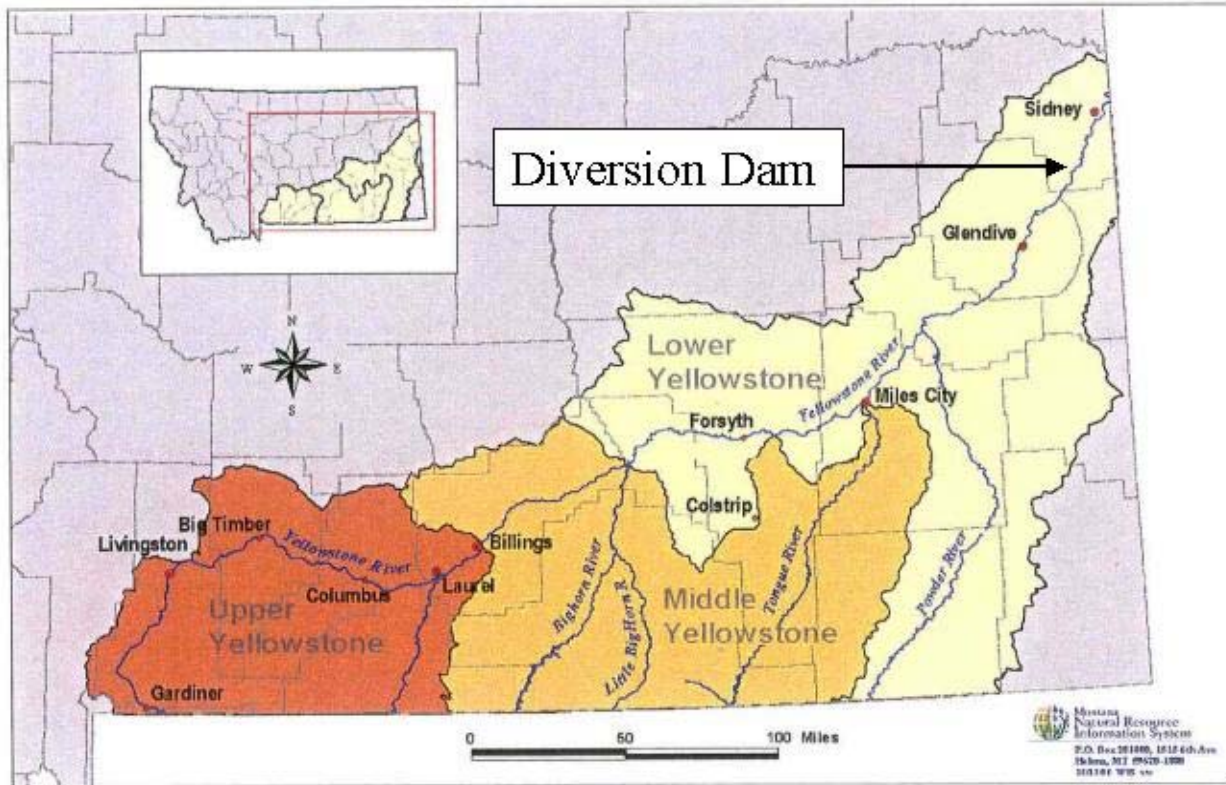


Figure 1 - Project Map for Lower Yellowstone River Irrigation Dam, Fish Protection and Passage Project

Six alternatives are currently being considered to meet the Federal project objectives stated above. These are:

1. Relocate Diversion Upstream
2. Relocate Main Channel
3. Rock Ramp
4. V-Shaped Screen
5. Single Pumping Plant
6. Removable Rotating Drum Screens

Alternatives 1, 2, 3 and 5 address the issue of fish passage up the Yellowstone River, and Alternatives 4 and 6 address two screen options to minimize fish entrainment in the irrigation channel. A more detailed presentation can be found in **Appendix A**.

ASSUMED BASELINE DESIGN

In developing alternatives and their cost impacts, a baseline design needs to be assumed or developed for comparison purposes. In this case, the VE team was instructed to utilize the proposed 1% slope rock ramp design concept combined with

removable, rotating, submerged, cylindrical screens. This concept consists of replacing the existing dam with a concrete weir and providing a downstream rock ramp at a 1% slope to facilitate passage of pallid sturgeon. The material to be used to construct the ramp is to consist of locally available quarry stone.

The selection of this baseline was in the general consensus of the VE team based on the current status of modeling. The 1% slope was utilized as the base condition to represent the potential average slope of the entire ramp recognizing that the slope will likely vary from very flat at the crest to a steeper slope at the toe. On-going hydraulic modeling will optimize the final slope, but using the 1% for quantity and cost estimating was deemed appropriate for this VE study.

COST ASSESSMENT

The VE Team was provided with preliminary/planning level cost estimates for various options under consideration to use as a guide in making the general comparisons associated with individual alternatives. For the purpose of this study, the option consisting of replacing the existing dam with a concrete weir, a downstream 1% slope rock ramp composed of quarried boulders, and 14 removable rotating drum screens would serve as the baseline design. The summary table of total costs for the baseline design is presented in **Appendix B**. The VE team did not make any judgments as to the accuracy or completeness of the estimate. The current total project cost estimate, as of May 26, 2009, is \$38,433,526.

PROJECT ANALYSIS

The SAVE International VE tools and Job Plan were used by the VE team to analyze the project. The results of these analyses clarified the programmatic objectives and major project functions in terms of performance attributes developed by the team. The key performance attributes, described in detail in **Appendix A**, were:

- Fish Performance
- Water Delivery Reliability
- Engineering Design & Construction
- Operations & Maintenance
- Cost Effectiveness

The team enlisted the assistance of the project managers, biologists and designers from the USACE Omaha District, USACE Walla Walla District Lower, Yellowstone Irrigation District and U.S. Bureau of Reclamation (USBR).

Team and Stakeholder Issues

In preparing to enter the Evaluation Process, the VE team first participated in an exercise whereby they identified critical issues they saw to be important to the project. In doing so, the team members were able to focus on these items and develop alternatives relevant to the critical issues in addition to the project functions.


Two lists were developed. The first identified project constraints and the second critical issues the VE team felt were still open where additional information would eventually be needed for a complete assessment. The Project Constraints and Critical Issues identified are presented in **Appendix A**.

VE ALTERNATIVES

The VE team developed 12 project alternatives that may potentially improve the project value. The alternatives and comments were developed by referring to the functional categories developed during the function analysis of the study as a stimulus to creative thinking, including: *manage resources, restore ecosystem, support agriculture, and sustain recreation*. Other significant functions include *recover pallid sturgeon, protect species, restore habitat, create habitat, diversify habitat, pass fish, prevent/minimize entrainment and deliver water*. The critical issues discussed above were also consulted regularly during the process to assure that all concerns raised in the study were addressed.

A summary list of the alternatives is presented below. The reader should note that this list represents, in most cases, a combination of Speculation Ideas where appropriate. Detailed documentation of these key alternatives is contained in the Value Engineering Alternatives Section of this report. It is also important to note that the listed alternatives generally represent individual concepts. Combinations of these concepts can, and should, be considered as possible additional comprehensive options. The comments and suggestions are presented later in this report.

Additionally, two VE Strategies were developed and are presented below. It should be noted that three proposals (4.0 - Make the initial half of ramp 550' wide and build in the dry on the south side of the existing dam; 5.3 - Install overshot gates; and 8.0 - Utilize synthetic materials to construct ramp) were dropped from consideration for the VE Strategies as their added cost to the project were considered to be excessive. They are retained in the report as a source of information to the reader.

SUMMARY OF VE ALTERNATIVES Lower Yellowstone River Irrigation Dam – Fish Protection and Passage		
Number*	Description	Project Costs Savings/ (Additions)
1.0	Use pre-cast concrete box section for dam replacement	\$669,000
2.0	Construct an earthen dam to replace the concrete wall at the headworks	\$723,000
3.0	Increase number of screens to 16 for redundancy	(\$2,827,000)
4.0	Make the initial half of ramp 300' wide and build in the dry on the south side of the existing dam	(\$6,009,000)
5.1	Build an on-channel flat-plate screen and incorporate ice protection	\$2,628,000
5.2	Set headworks back further to lessen amount of required cofferdam work	\$54,000
5.3	Install overshot gates	(\$8,217,000)
6.0	Construct low flow channel in ramp out of concrete, gunite or grout to fix location	(\$1,333,000)
7.1	Consider a layered material (including fieldstone) system for ramp	\$4,796,000
7.2	Use sediment-filled geotubes to create dam and/or ramp	\$5,732,000
7.3	Build ramp to ~90% complete in the wet and complete in low flow season	\$557,000
8.0	Utilize synthetic materials to construct ramp	(\$34,044,000)

*Some alternatives are considered to be competing alternative where only one may be selected for implementation. These are numbered as 5.1, 5.2, 5.3 (for example). Those non-competing alternatives are numbered as 1.0, 2.0 (for example).

No.	Strategy Description	Project Costs Savings/ (Additions)
1	VE Strategy 1 – 16 Rotating, Submerged, Removable Cylindrical Screens with Layered Ramp (Alternatives 3.0 & 7.1)	\$1,969,000
2	VE Strategy 2 – On-Channel Flat-Plate Screens with Layered Ramp (Alternatives 5.1 & 7.1)	\$7,424,000

VE TEAM AND PROCESS

The five-day study was performed during the period of June 1-5, 2009, at the office of U.S. Army Corps of Engineers, Omaha, Nebraska. An exit briefing was held at the end of the workshop. Ron Tanenbaum, GeoVal, Inc., facilitated the VE study. The VE team members are listed below (see **Appendix E** – Contact Directory and Attendance):

Ronald J. Tanenbaum, CVS, PhD, PE, GE	GeoVal, Inc.
Richard Stricker, CCC, AVS, VEO	USACE – Omaha District
Teresa A. Reinig	USACE – Omaha District
Greg Johnson	USACE – Omaha District
Tiffany Vanosdall	USACE – Omaha District
Dan Pridal, PE	USACE – Omaha District
Catherine Juhas	USACE – Billings Regulatory Office
Terry Matuska	USACE – Omaha District
Lyle Peterson, PE	USACE – Omaha District
Dwight D. Pochant, PE	USACE – Ellsworth Office
Stephen R. Graf, PE	USACE – Omaha District
Sean C. Milligan, PE	USACE – Walla Walla District
Clayton Jordan, PE	U.S. Bureau of Reclamation
Jerry Nypen	Lower Yellowstone Irrigation District
Gary Norenberg	USACE – Omaha District
Nell McPhillips	U.S. Bureau of Reclamation
Scott Flash	USACE – Omaha District

Throughout the VE session, members of the USACE Omaha and Walla Walla Districts, Lower Yellowstone Irrigation District and U.S. Bureau of Reclamation (USBR) supported the VE team.

Value Engineering is a strictly adhered-to process that follows specific steps and procedures. The specific steps in the VE process, also known as the VE Job Plan, are as follows:

Step 1. Preparation – developing a basic understanding of the client's/user's needs and requirements, specific goals and current costs with an agreement on the scope of the study.

Step 2. Information – which is gathered prior to and during the study, and is reviewed and discussed with the team. A summary of project constraints and critical issues can be found as **Appendix A**.

Step 3. Function Analysis – defines the functions of the project through an organized use of the Function Analysis System Technique (FAST) diagram that shows how the functions are related to one another. A FAST diagram was developed for this study and is shown in **Appendix C**.

Step 4. Speculation – also known as creativity – is the application of brainstorming techniques to develop a large quantity of ideas rather than the quality of ideas. A complete list of workshop ideas can be found as **Appendix D**.

Step 5. Evaluation – reduces the large quantity of ideas to a few high quality ideas.

Step 6. Development – the concepts identified in the evaluation phase are developed into specific recommendations/alternatives that have been technically validated and quantified as much as possible.

Step 7. Presentation/Report – containing the team's recommendations and a presentation to the management group to receive their approval of these recommendations.

Step 8. Implement and Audit – tracking the implementation of projects and auditing the results measure the effectiveness of the value engineering effort.

The VE Job Plan was followed to analyze the criteria/functions of the project and the issues of concern, create and evaluate ideas for change, and develop and present alternatives to the project team and stakeholders. The study concluded with the informal presentation of the VE alternatives and suggestions.

VALUE ENGINEERING ALTERNATIVES

EVALUATION PROCESS

The VE team, as a group, generated and evaluated ideas on how to represent the various major components/functions identified that would enhance decisionmakers' ability to select the best proposals that would produce a high level of performance at an acceptable level of cost to achieve the stated goals of the Lower Yellowstone River Irrigation Dam, Fish Protection and Passage Project as described in **Appendix A**. The idea list (see **Appendix D**) was based on the key criteria listed above and the function analysis performed by the VE team.

The team evaluated each of the ideas with respect to current conditions for each of the key evaluative criteria to determine whether it was better than, equal to, or worse than the status quo. The team reached a consensus on the ranking of the idea. High-ranked ideas would be developed further; low-ranked ones would be dropped from further consideration.

All of the numerous ideas that were generated during the creative phase using brainstorming techniques were recorded on the Idea Evaluation Form worksheets presented in **Appendix D**. These ideas were discussed and the advantages and disadvantages of each were debated. Once an idea was fully evaluated, it was rated as described later in this report, **Value Engineering Process**. All readers are encouraged to review the creative idea listings in the Idea Evaluation Form, because even the low-rated or rejected ideas may suggest additional ideas that can be applied to the project.

VE ALTERNATIVE CONTENT AND SPECIAL NOTES

Each alternative consists of a summary of the original concept, a description of the suggested change, a listing of its advantages and disadvantages, and a brief narrative describing the justification for the proposed change.

Alternative order-of-magnitude cost estimates compare relative items of the current design and proposed change for the sole purpose of estimating the net difference between the two options. In several cases, the estimates do not include the total feature cost but only those components that are changed by the alternative.

The reader should note that the efforts of the VE team in developing the alternatives in the short time period of the VE Study limits their findings to conceptual level analyses and rough order-of-magnitude cost comparisons only. The descriptions contained in the alternatives presented do not represent detailed design nor do they provide equally detailed cost estimates.

It should also be noted that some of alternatives may 'conflict' with others. That is to say that one option cannot be implemented with the other. Such competing alternatives have been published without relative rating or exclusion such that various alternatives may be considered by the designers and prospective bidders.

VALUE ENGINEERING ALTERNATIVE

Project: Lower Yellowstone River Irrigation Dam, Fish Protection and Passage

ALTERNATIVE NO: 1.0

PAGE NO: 1 OF 7

TITLE: Use pre-cast concrete sections for dam replacement

ORIGINAL DESIGN: Cast-in-place concrete weir upstream of existing dam. The foundation requirements have not been determined for the concept design.

PROPOSED DESIGN: Precast concrete boxes, placed in wet with crane on barge, filled blockout for piles with grout after set in place.

ADVANTAGES:

- Can be a contractor option
- Can pre-fabricate precast units and stockpile on-site in advance
- Float in sections or bring in by rail, or precast on the bank
- May not need to dewater (depending on foundation requirements, and ability to prepare firm and level base in the wet)
- May shorten construction duration

DISADVANTAGES:

- Need to have prepared base and foundation
- Difficult to anchor to piles (if piles required)
- Need to be tied together to maintain crest elevation and location, ties susceptible to corrosion
- Larger number of joints than with cast-in-place

COST ASSESSMENT SUMMARY:

COST SUMMARY	Present Worth Values For:				
	Initial CWE Costs	Replacement & Future Costs	Salvage Value	O&M Costs	Total Life Cycle Costs
Original Concept	\$4,271,000	\$0	\$0	\$0	\$4,271,000
Alternative Concept	\$3,612,000	\$0	\$0	\$0	\$3,612,000
Savings / (Expense)	\$659,000	\$0	\$0	\$0	\$659,000

Overall Performance Assessment:

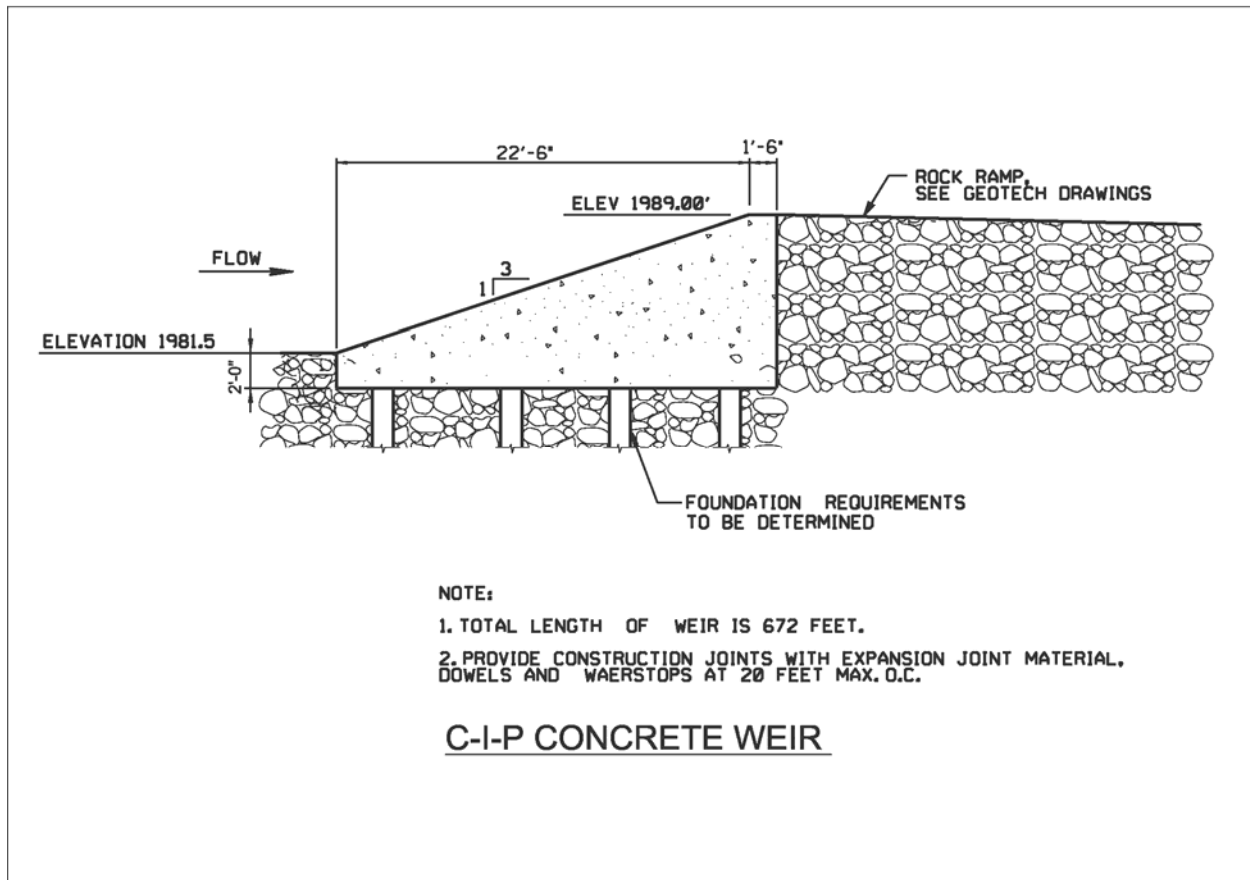
The large number of joints between precast units could become a maintenance issue. Otherwise, precast performance would be equal to cast-in-place.

DISCUSSION/JUSTIFICATION

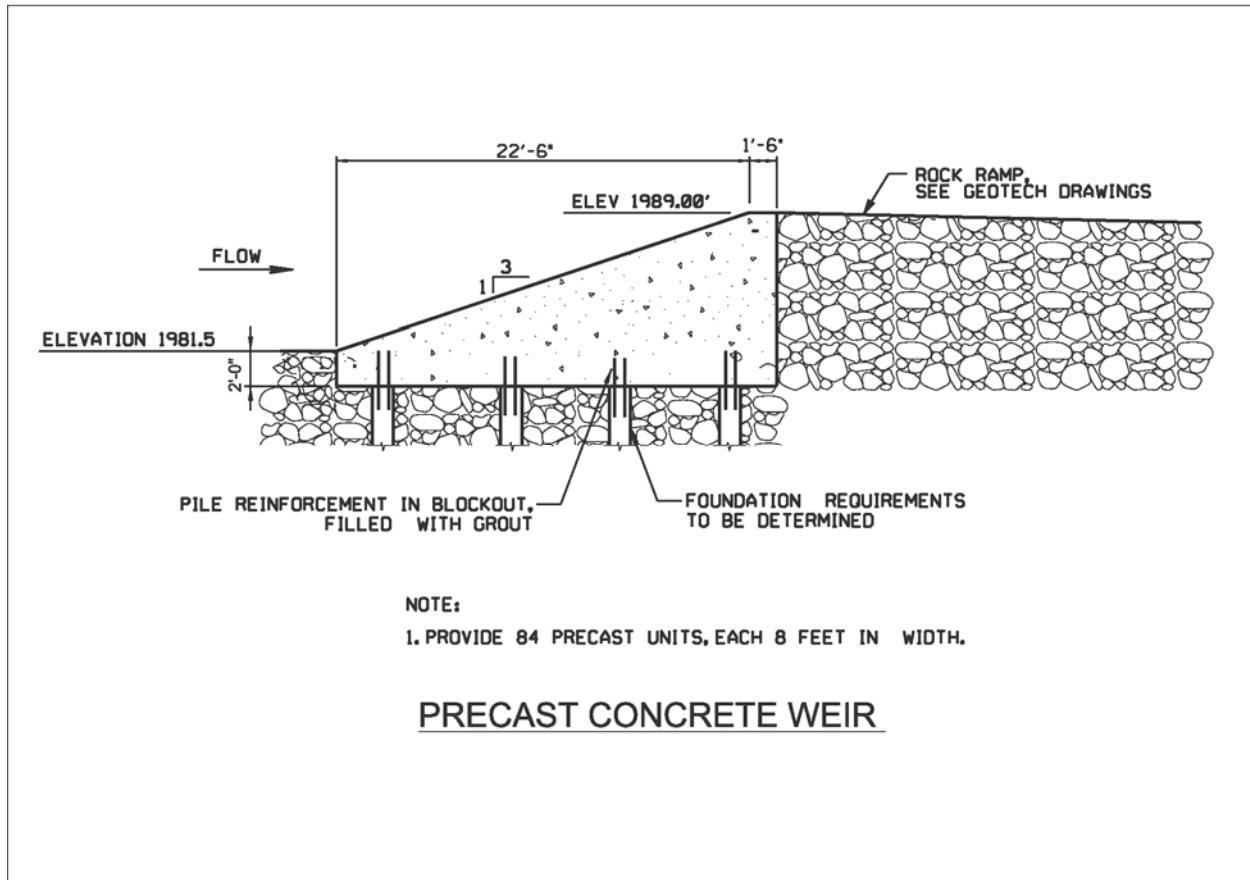
Savings shown are all due to elimination of the cofferdam and depend on being able to construct both the weir and the ramp in the wet. Therefore, savings shown should be shared between precast weir alternative, and any alternative that allows constructing the ramp in the wet.

Advantage of precast weir over cast-in-place weir depends on ability to construct with precast in the wet. Constructability concerns remain regarding preparing a firm, level base in the wet, and ability to anchor precast units to piles. These concerns are significant, but this alternative should be explored further during final design. It is also suggested that the Omaha District engineers consult with engineers in the New Orleans District where there is considerable experience with this construction technique.

DRAWING/SKETCH CURRENT DESIGN



DRAWING/SKETCH PROPOSED IDEA



COST ANALYSIS – INITIAL COSTS

[illegible]

ASSESSMENT OF PERFORMANCE ATTRIBUTES

Fish Performance (FP): No significant impact.

Water Delivery Reliability (WDR): No effect after construction is complete. Reduced on-site construction time with precast may reduce the risk of interruption of water delivery

Engineering Design & Constructibility (EDC): No difference in design effort. Use of precast may permit construction of the weir without cofferdams if a stable base or foundation for the weir can be constructed in the wet. Constructability remains a concern, and should be investigated further during design.

Operations & Maintenance (O&M): Precast concrete would have better quality control of the concrete mix, especially if high-strength or other specialty concretes with enhanced durability are desired.

Cost Effectiveness (CE): With the elimination of the cofferdam and construction in the wet, the project may realize a cost savings over the baseline design.

ASSUMPTIONS & CALCULATIONS

For the V-screen alternative, it was assumed that the new concrete weir could be placed on top of the existing timber piles in the existing dam. For the 10% concept design of the alternative to construct headworks upstream of existing headworks and weir upstream of the existing dam, the foundation for the weir was not designed. For this proposal to use precast concrete for the weir, it is assumed that foundation requirements are similar to those for the cast-in-place weir. Therefore foundation costs and effect of foundation on performance are assumed to be the same for either cast-in-place or precast.

C-I-P concrete weir quantities

(It appears the baseline cost estimate used two different lengths for various items.)

Cross sectional area = $24.167 \times 9.5 - 0.5 \times 22.667 \times 7.5 = 144.5$ square feet

Volume = $144.5 \times 750 / 27 = 4013$ CY

Floor area = $1.5 + (22.67^2 + 7.5^2)^{0.5} = 25$ feet per linear foot of weir

Floor screeding and finishing = $25 \times 670 = 16,750$ square feet

Forms on upstream = $2 \times 670 = 1,340$ square feet

Forms on downstream = $9 \times 670 = 6,030$ square feet

Precast concrete weir quantities

Weight of weir = $144.5 \times 150 / 2000 = 10.84$ tons per linear foot

For max. pick of 90 tons, max. length of unit = $90 / 10.84 = 8.3$ feet

Number of units = $672 / 8 = 84$

Total volume = Assume 4,013 CY for Precast Units to Allow Filling Space with Concrete After Placement

VALUE ENGINEERING ALTERNATIVE

Project: Lower Yellowstone River Irrigation Dam, Fish Protection and Passage

ALTERNATIVE NO: 2.0

PAGE NO: 1 OF 7

TITLE: Construct an earthen embankment to replace the concrete wall at the headworks

ORIGINAL DESIGN: The baseline condition is the construction of a new headworks structure with rotating removable drum screens with irrigation canal extension. Further detail of this option is located in the 10 percent design report.

PROPOSED DESIGN: The proposed design would be to construct an earthen embankment with gated pipes through the embankment. The rotating removable drum screens would be used to provide fish entrainment protection.

ADVANTAGES:

- Save structural concrete
- Shorten construction duration
- May improve seal between screen and manifold

DISADVANTAGES:

- Need to design berm and rails to resist ice forces
- More difficult to maintain shutoff gates behind screens
- Need to address settlement

COST ASSESSMENT SUMMARY:

COST SUMMARY	Present Worth Values For:				
	Initial CWE Costs	Replacement & Future Costs	Salvage Value	O&M Costs	Total Life Cycle Costs
Original Concept	\$3,573,000	\$0	\$0	\$0	\$3,573,000
Alternative Concept	\$2,850,000	\$0	\$0	\$0	\$2,850,000
Savings / (Expense)	\$723,000	\$0	\$0	\$0	\$723,000

Overall Performance Assessment: Additional investigations would be necessary to achieve an accurate cost estimate. A quick look at the alternative nets a cost savings for the project. Long term operation and maintenance may present a problem.

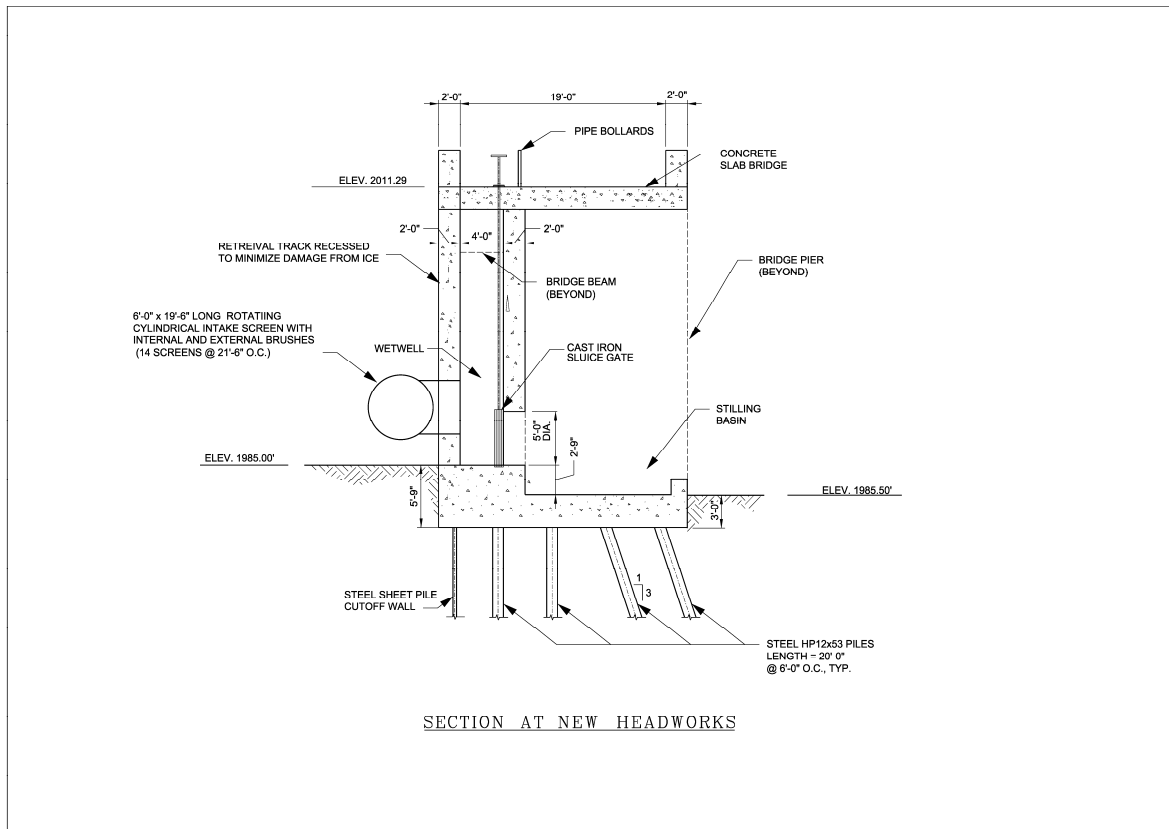
DISCUSSION/JUSTIFICATION

An earthen embankment was considered because of the potential cost saving by using less structural concrete.

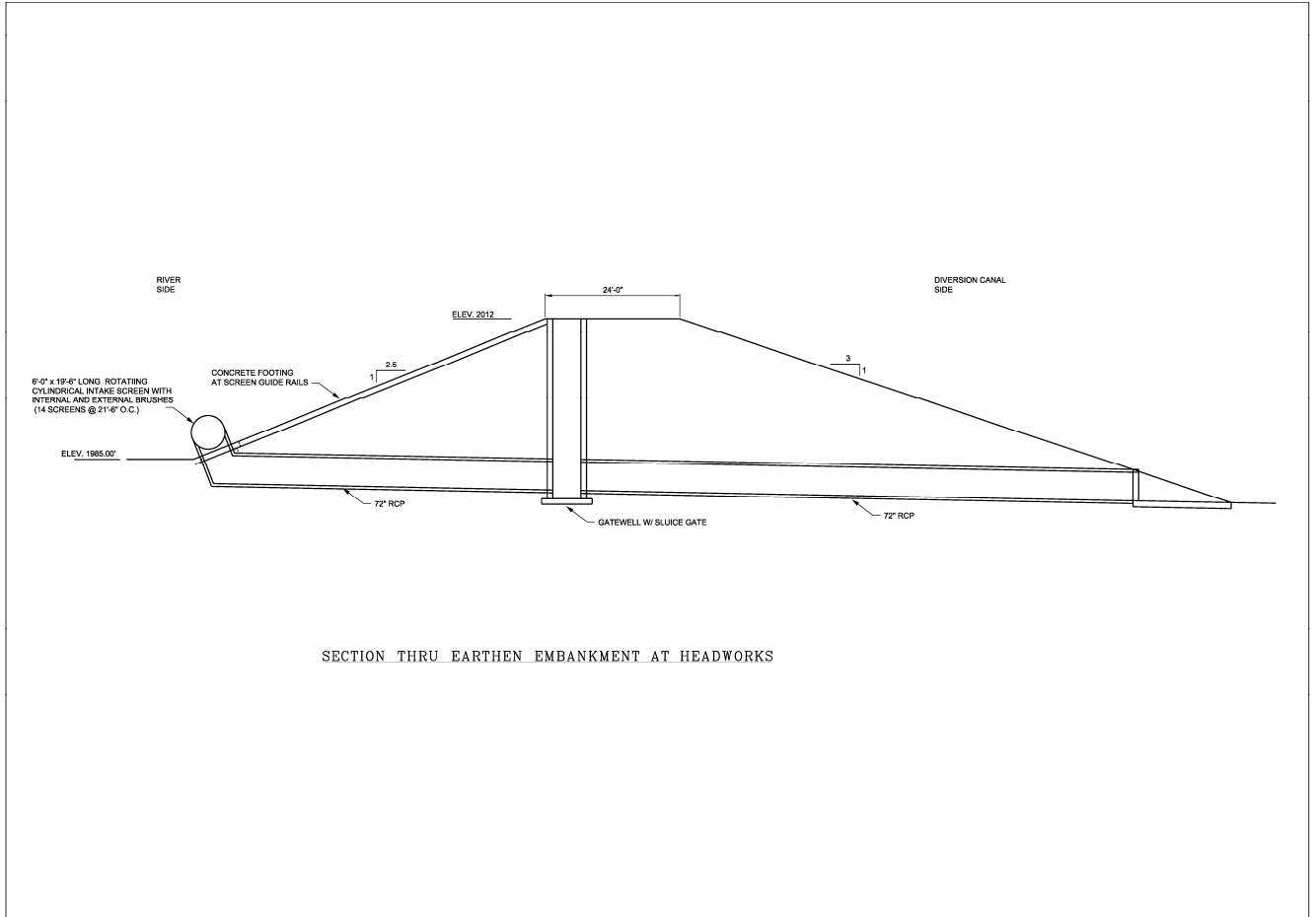
The gates would be installed on a 2.5 to 1 slope. One of the cylindrical screen manufacturers recommends a slanted screen installation to take advantage of gravity for getting a better seal between the screen and the intake pipe.

Ice effects on the earthen embankment may be less than the on the headworks structure in the baseline condition. However, maintenance on the control gates could be more difficult for an earthen embankment.

DRAWING/SKETCH CURRENT DESIGN



DRAWING/SKETCH PROPOSED IDEA



COST ANALYSIS – INITIAL COSTS

CONSTRUCTION ELEMENT		ORIGINAL CONCEPT			ALTERNATIVE CONCEPT		
Description	Unit	Quantity	Cost/Unit	Total	Quantity	Cost/Unit	Total
Steel HP piles	VLF	3,040	31	\$95,334			\$0
Steel sheet pile cutoff wall	SF	6,140	32	\$199,366			\$0
Concrete bottom slab	EA	1	401,726	\$401,726			\$0
Concrete sidewalls	EA	1	283,193	\$283,193			\$0
Concrete wetwell walls	EA	1	281,524	\$281,524			\$0
Concrete bridge pier	EA	1	242,927	\$242,927			\$0
Concrete endwalls	EA	1	43,716	\$43,716			\$0
Concrete slab bridge	EA	1	249,204	\$249,204			\$0
Concrete edgewalls on bridge	EA	1	94,033	\$94,033			\$0
Concrete access bridge	EA	1	283,510	\$283,510			\$0
Concrete wingwall	EA	1	207,770	\$207,770			\$0
				\$0			\$0
Earthen dam compacted fill	CY			\$0	49,800	\$10	\$498,000
RCP 72"	LF			\$0	2,800	\$380	\$1,064,000
Pipe bedding	CY			\$0	415	\$27	\$11,205
Concrete footings at screen rails	CY			\$0	600	\$275	\$165,000
Concrete footings at gatewalls	CY			\$0	85	\$275	\$23,375
Concrete walls, gatewells	CY			\$0	185	\$750	\$138,750
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				\$0			\$0
				\$0			\$0
TOTAL CONSTRUCTION COST:				\$2,382,303			\$1,900,330
Owner Mark-Up Injcluding Contingency	50%			\$1,191,152			\$950,165
TOTAL CWE:				\$3,573,000			\$2,850,000
						SAVINGS	\$723,000

ASSESSMENT OF PERFORMANCE ATTRIBUTES

Fish Performance (FP): There may be an improvement to the seal between the rotating drum screen and the intake pipe. This tighter seal may improve the performance of the screen.

Water Delivery Reliability (WDR): There wouldn't be any measurable change to water delivery with this alternative.

Engineering Design & Constructibility (EDC): Although the structural concrete required for this alternative would be less, this alternative would likely present other design and construction challenges. Therefore, there isn't an expected overall change for this alternative.

Operations & Maintenance (O&M): Protection from ice could potentially be an improvement over the baseline condition. However, maintenance on the gates could be more difficult.

Cost Effectiveness (CE): This alternative may cost less than the baseline condition.

ASSUMPTIONS & CALCULATIONS

- Used local material for the earthen embankment compacted fill
- Does not include slope protection for river side part of the dike

VALUE ENGINEERING ALTERNATIVE

Project: Lower Yellowstone River Irrigation Dam, Fish Protection and Passage

ALTERNATIVE NO: 3.0

PAGE NO: 1 OF 6

TITLE: Increase number of screens to 16 for redundancy

ORIGINAL DESIGN:

Diversion Headworks Structure (DHS) with 14 slide gates, 100 cfs capacity each.

PROPOSED DESIGN:

Diversion Headworks Structure with 16 slide gates, 100 cfs capacity each.

ADVANTAGES:

- Minimizes interruption of canal flow during routine maintenance and unpredictable maintenance events.

DISADVANTAGES:

- Higher cost.

COST ASSESSMENT SUMMARY:

	Present Worth Values For:				
COST SUMMARY	Initial Costs	CWE Replacement & Future Costs	Salvage Value	O&M Costs	Total Life Cycle Costs
Original Concept	\$19,793,000	\$0	\$0	\$0	\$19,793,000
Alternative Concept	\$22,620,000	\$0	\$0	\$0	\$22,620,000
Savings / (Expense)	(\$2,827,000)	\$0	\$0	\$0	(\$2,827,000)

Overall Performance Assessment:

The original plan lacks any redundancy for unavoidable circumstances such as screen blockage, screen damages, silt congestion, and mechanical problems. These unavoidable circumstances are certain to lessen the flow in the irrigation main canal. Lessening the flows during high irrigation demand and full flow conditions result in crop stress and financial impact on the irrigation project.

It is necessary to pull one or more screens during these events for repair or replacements. In the baseline design, it is likely that the facility would continue to operate without the protection of the screens: fish entrainment would occur. Repairs or replacements of screen and screen parts can take some time considering the remote area the facilities are in. This alternative adds benefits that outweigh the additional cost.

DISCUSSION/JUSTIFICATION

Fish screens in the river ahead of the Diversion Headworks Structure present some risk that they will always perform as intended. The screens are lowered into the waters of a very dynamic river system in April-May each year and are to operate non-stop until September or October.

The screens will be exposed to floating debris, generally trees and limbs that are sure to get snagged on the screens. Periodically raising the screens to inspect and clean them is an expected event. Submerged debris could lodge on a screen to the extent that the screen becomes inoperable.

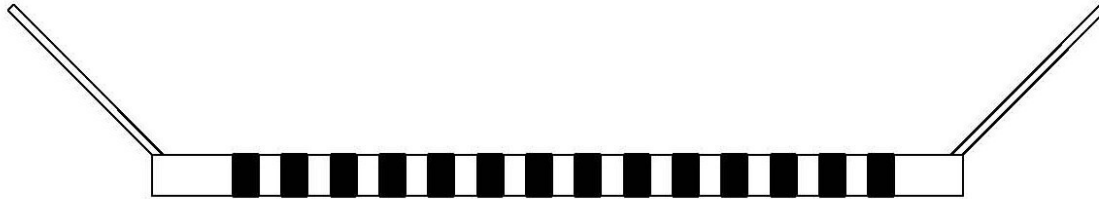
Debris of size, weight, and momentum could impact the screen and damage it sufficiently to require removal and repair. Silt deposits in and around the screen area could disable the screens.

The screens are vulnerable to mechanical problems with the screen seals, motor drive, hydraulic lines, the position seal, and the rails.

Loss of full canal flow which occurs for about 90 days during the season results in crop stress and crop revenue. It is very difficult to recover a reduction of flow that lasts more than 5 hours in a reasonable time period.

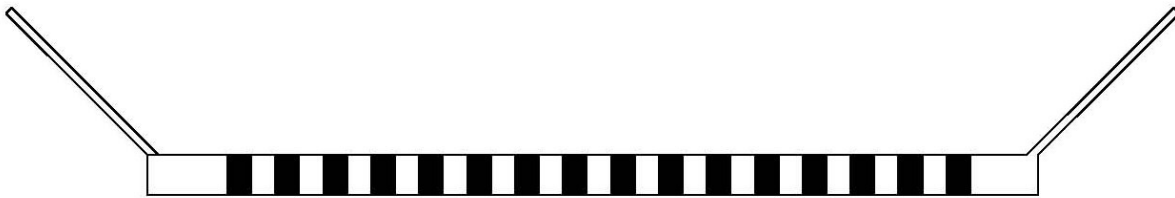
Two additional gates and screens, to provide a desired redundancy and allow maintenance without impeding operations, are justifiable in this case.

DRAWING/SKETCH CURRENT DESIGN



14 Gates and Screens

DRAWING/SKETCH PROPOSED IDEA



16 Gates and Screens

COST ANALYSIS – INITIAL COSTS

[illegible]

ASSESSMENT OF PERFORMANCE ATTRIBUTES

Fish Performance (FP): Adding redundancy increases reliability of keeping the diversion screened at all times.

Water Delivery Reliability (WDR): Adding the 2-gate redundancy reduces the risk of losing canal flows due to screen failure.

Engineering Design & Constructibility (EDC): Adding the 2-gate redundancy is a matter extending the length of the diversion headworks structure (DHS). It may be necessary to tie the new DHS closer to the existing DHS because of limited space.

Operations & Maintenance (O&M): There are pluses and minuses that balance out by implementing this alternative. Additional space to house the screens during the non-season, additional time in mounting and extracting the screens, and some additional responsibilities because of the size of the DHS is offset by costly “rush-type” repairs. The alternative reduces the operation costs in recovering a drop in canal flow that can occur with baseline facilities.

Cost Effectiveness (CE): This alternative represents an increase in size of the DHS that can be done with ease. The added costs enhance both the responsibilities of fish protection and irrigation water diversion.

ASSUMPTIONS & CALCULATIONS

Cost was arrived by adding 14.29% to the all baseline cost of the Diversion Headworks Structure.

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VALUE ENGINEERING ALTERNATIVE

Project: Lower Yellowstone River Irrigation Dam, Fish Protection and Passage

ALTERNATIVE NO: 4.0

PAGE NO: 1 OF 7

TITLE: Make the initial half of ramp 550' wide and build in the dry on south side of existing dam

ORIGINAL DESIGN: The ramp was constructed entirely in the dry by using a cofferdam system.

PROPOSED DESIGN: The ramp would be partially constructed in the Joe Island area which would not require a cofferdam and would be done in the dry. The rock ramp would be able to be constructed in a more controlled manner to achieve installation and design requirements.

ADVANTAGES:

- Build in dry
- Better quality control

DISADVANTAGES:

- Would need to fill in portion of river not being used for ramp
- Dam would be longer
- Need to replace cable system for maintenance

COST ASSESSMENT SUMMARY:

COST SUMMARY	Present Worth Values For:				
	Initial CWE Costs	Replacement & Future Costs	Salvage Value	O&M Costs	Total Life Cycle Costs
Original Concept	\$94,000	\$0	\$0	\$320,000	\$414,000
Alternative Concept	\$6,103,000	\$0	\$0	\$160,000	\$6,263,000
Savings / (Expense)	(\$6,009,000)	\$0	\$0	\$160,000	(\$5,849,000)

Overall Performance Assessment:

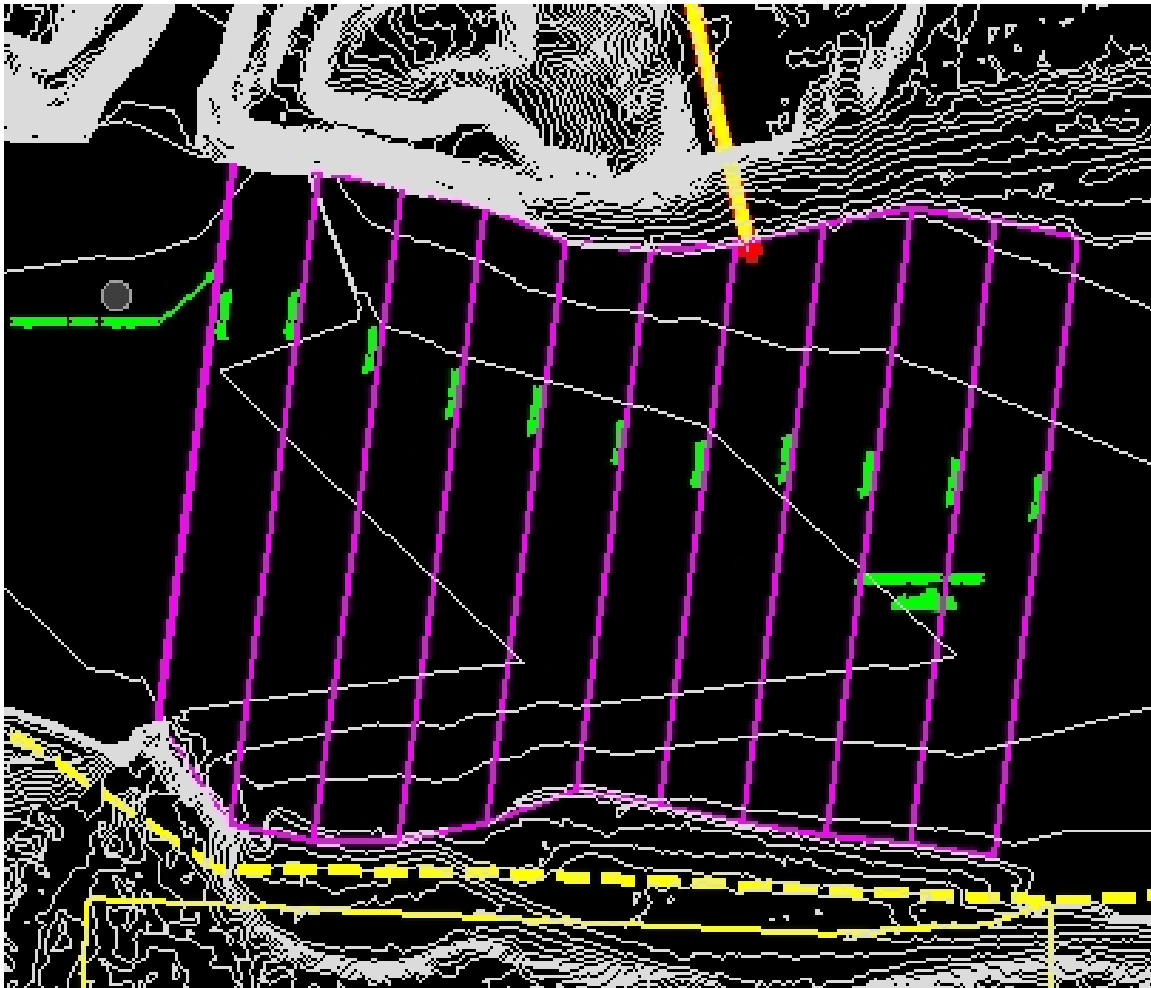
The overall performance would be similar if not better than the original design except for the guiding of fish away from the thalweg. This alternative is considered to be cost prohibitive.

DISCUSSION/JUSTIFICATION

The alternative could be feasible if the entire ramp would be constructed in the Joe Island area and some additional crest work performed on the existing dam. There would be no need for cofferdams and the ramp constructed to hydraulic and fish passage requirements.

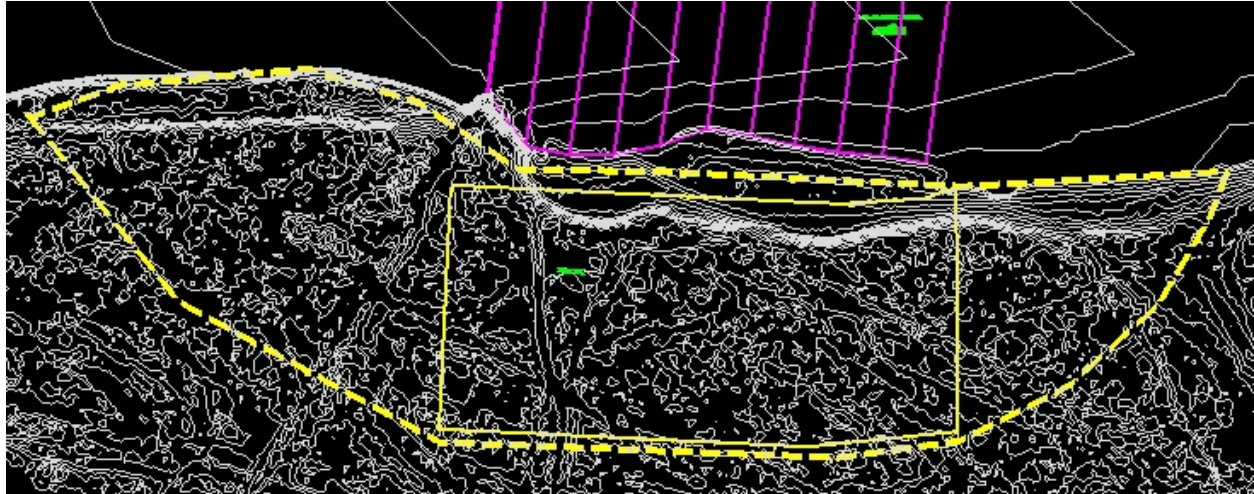
The hydraulic and fish passage limitations did not allow this alternative to be evaluated as planned.

DRAWING/SKETCH CURRENT DESIGN



TITLE: Make the initial half of ramp 550' wide and build in the dry on south side of existing dam

DRAWING/SKETCH PROPOSED IDEA



TITLE: Make the initial half of ramp 550' wide and build in the dry on south side of existing dam

TITLE: Make the initial half of ramp 550' wide and build in the dry on south side of existing dam

TITLE: Make the initial half of ramp 550' wide and build in the dry on south side of existing dam

TITLE: Make the initial half of ramp 550' wide and build in the dry on south side of existing dam

ASSESSMENT OF PERFORMANCE ATTRIBUTES

Fish Performance (FP): There would not be adverse affects to fish performance with this alternative as analyzed.

Water Delivery Reliability (WDR): There would not be adverse affects.

Engineering Design & Constructibility (EDC): The engineering effort or design difficulty would not be increased, and the constructability would be simplified to some degree.

Operations & Maintenance (O&M): The O&M may be similar to the current design, although the added length of structure would need to be considered reading the amount of maintenance required..

Cost Effectiveness (CE): The cost effectiveness has decreased after doing this analysis.

ASSUMPTIONS & CALCULATIONS

Riprap:

$$724,966 \text{ ft}^2 \times 3 \text{ ft.} = 2,174,898 \text{ ft}^3 = 80550 \text{ yd}^3 = \underline{132,910 \text{ Tons}}$$

Geotextile:

$$1,700,000 \text{ ft}^2 / 9 = \underline{189,000 \text{ yd}^2}$$

Earthwork:

Using Average-End

10,000 ft² @ 2002 Elevation

$$1,223,728 \text{ ft}^2 @ 2000 \text{ Elevation} = 1,233,728 \text{ ft}^3$$

$$1,500,000 \text{ ft}^2 @ 1989 \text{ Elevation} = 14,980,504 \text{ ft}^3$$

Using Prism

$$1723 \times 0.5 \times 550' \times 10' = 4,738,250 \text{ ft}^3$$

$$\text{Upstream of crest} = 1,187,518 \text{ ft}^3$$

$$(1,233,728 + 14,980,504 + 4,738,250 + 1,187,518) / 27 = \underline{820,000 \text{ yd}^3}$$

VALUE ENGINEERING ALTERNATIVE

Project: Lower Yellowstone River Irrigation Dam, Fish Protection and Passage

ALTERNATIVE NO: 5.1

PAGE NO: 1 OF 8

TITLE: Build an on-channel inclined flat-plate screen and incorporate ice protection

ORIGINAL DESIGN: The original design proposes to use a series of 14 submerged rotating drum screens with integrated brush cleaning mechanisms, such as a product made by Intake Screens, Inc.

PROPOSED DESIGN: This proposal suggests using inclined flat-plate bar screens located on the river bank in place of the submerged drum screens.

ADVANTAGES:

- Less likely to be damaged by debris, as there is a smooth flat surface along the river bank rather than cylindrical screens that project out into the river.
- Screens are less sensitive to debris damage. Rotating drum screens are more sensitive to distortions in shape caused by impact damage that compromise the seals and may impair the rotation.
- Easier to put a trash rack or bollards in front of the screen if necessary because the screen does not project out into the river.
- There are fewer moving parts, which increases reliability and reduces operation and maintenance requirements. The screens themselves are fixed, with no submerged drive motors.
- Inclined flat-plate screens are very common, proven technology.
- Reduces the number of control gates required.
- Initial cost for the screens is likely less.

DISADVANTAGES:

- Needs a longer headworks section to accommodate the required screen area.

COST ASSESSMENT SUMMARY:

COST SUMMARY	Initial CWE Costs	Replacement & Future Costs	Salvage Value	O&M Costs	Total Life Cycle Costs
Original Concept	\$8,478,000	\$6,596,000	\$0	\$0	\$15,074,000
Alternative Concept	\$5,850,000	\$2,012,000	\$0	\$0	\$7,862,000
Savings / (Expense)	\$2,628,000	\$4,584,000	\$0	\$0	\$7,212,000

Overall Performance Assessment: The performance regarding protecting fish from becoming entrained should be similar for both screens as long as both are designed to meet NOAA Fisheries criteria. However, the inclined flat-plate screens are a simpler design, with fewer moving parts, which increases water delivery reliability, makes design and construction easier, and reduces operation and maintenance requirements. The initial cost for the screens is likely less for the flat-plate screens, and there are fewer control gates required, but the headworks is longer. Overall construction and O&M costs are probably lower for the flat-plate.

DISCUSSION/JUSTIFICATION

The Yellowstone River has a high seasonal load of debris, some of which is large woody debris such as logs and root wads. Any screen that is located along the river bank or in the river itself should be able to withstand impacts from this large debris without significant damage. It is even better to minimize the likelihood of debris impacting the screen in the first place. An inclined flat-plate screen has little or no profile perpendicular to river flow since it is oriented parallel to the river bank. Submerged rotating drum screens must project out into the river to maintain sweeping velocity past the screens.

In addition, rotating drum screens are more sensitive to damage from debris impacts. The effectiveness of the screen relies on the integrity of the seals around the circumference of the drum at each end. If a section of the screen is bent, or the cylinder is distorted out of true round, the seals are compromised and can allow fish to pass through. The drive mechanism also works best when the cylinders are perfectly round, and are not as efficient if the cylinder shape is distorted.

Another significant advantage is there are no moving parts. The screen itself is fixed, so it does not require a drive motor. An air-burst cleaning system requires an air compressor, but all the submerged parts of the air manifold are also fixed in place. This increases reliability and reduces operation and maintenance requirements. Inclined flat-plate screens use common, well-established technology that has been used in many locations to prevent fish entrainment.

The air-burst cleaning manifold is mounted behind the screen face, so it is protected from damage from debris that may strike the screen. The exposed screen face is smooth, and fish cannot strike any parts of the cleaning system, as they could with a brush-type cleaning system mounted on the face of the screen. Using profile wire bar screen, with the bars oriented perpendicular to the river flow, also enhances cleaning efficiency.

Once through the screen, the headworks can transition to the open canal section, with a single control gate structure located in the canal section rather than separate control gates for each screen. This will also probably reduce operation and maintenance requirements.

Because the screen face is planar, rather than cylindrical, this configuration does require longer headworks to accommodate the required screen area. Individual control gates for each screen would be preferred to allow for removal/maintenance during irrigation diversions.

The initial cost for the screens elements is probably cheaper for the flat-plate screens, mainly due to simpler design and fabrication. The costs shown below for the flat-plate screens do not include an air-burst cleaning system, so are not directly comparable to the drum screen units, which have an integral cleaning system, but the cost of the air-burst system is not likely to be more than the savings shown (probably much less).

DRAWING/SKETCH CURRENT DESIGN

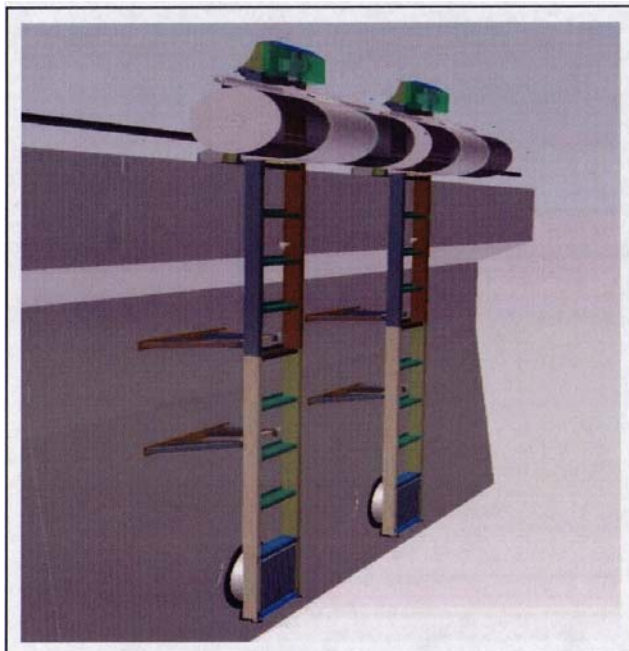
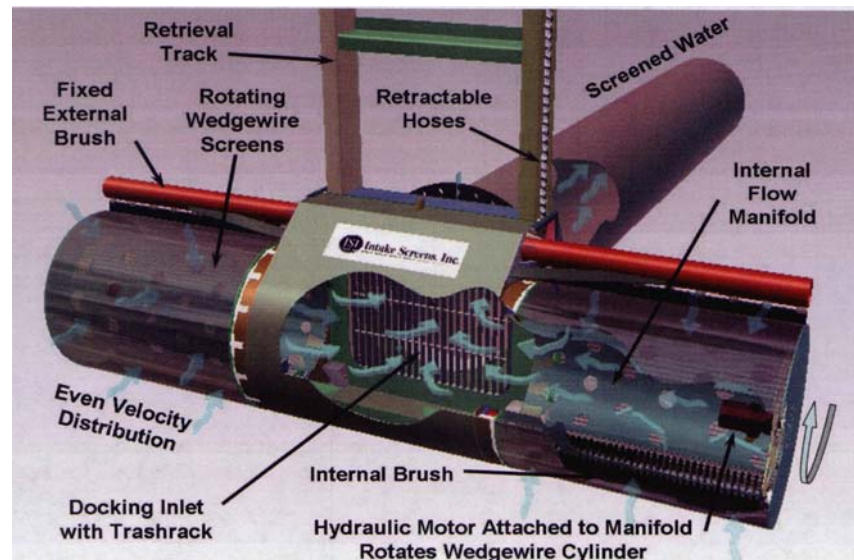


Figure 2. Concept Cylindrical Screens (raised position)

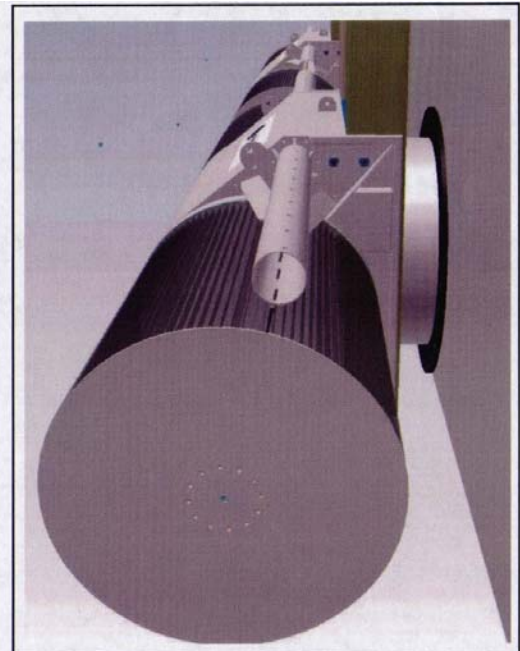


Figure 3. Concept Cylindrical Screens (side view)

COST ANALYSIS – INITIAL COSTS

CONSTRUCTION ELEMENT		ORIGINAL CONCEPT			ALTERNATIVE CONCEPT		
Description	Unit	Quantity	Cost/Unit	Total	Quantity	Cost/Unit	Total
Cylinder Screens	ls	1	\$5,652,260	\$5,652,260			\$0
Flat Screens (excluding airburst system)	sf			\$0	3,900	\$1,000	\$3,900,000
				\$0			\$0
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				\$0			\$0
				\$0			\$0
TOTAL CONSTRUCTION COST:				\$5,652,260			\$3,900,000
Owner Mark-Up Injcluding Contingency	50%			\$2,826,130			\$1,950,000
TOTAL CWE:				\$8,478,000			\$5,850,000
						SAVINGS	\$2,628,000

COST ANALYSIS – LIFE CYCLE COSTS

[illegible]

ASSESSMENT OF PERFORMANCE ATTRIBUTES

Fish Performance (FP): Should be about the same. Both screens are designed to satisfy NOAA Fisheries criteria.

Water Delivery Reliability (WDR): Should be better than the baseline system. The rotating drum screens have submerged drive motors and other moving parts that are subject to failure during the diversion season. The baseline system does not include any redundant screens to account for a screen being out of service.

Engineering Design & Constructibility (EDC): The inclined flat-plate screen configuration is a simpler design and will likely be easier to fabricate and install.

Operations & Maintenance (O&M): Again, with no submerged moving parts, the operation and maintenance will likely be less for the inclined flat-plate screens.

Cost Effectiveness (CE): Screen costs are lower for the flat-plate screens, and there can be fewer control gates, but the headworks are longer. Overall, the flat-plate screens are probably more cost effective.

ASSUMPTIONS & CALCULATIONS

Calculate screen area required:

Discharge, $Q = 1,400$ cfs

Maximum allowable approach velocity, $V_a = 0.4$ fps

Minimum required screen area, $A_s = 1,400 \text{ cfs} / 0.4 \text{ fps} = 3,500 \text{ ft}^2$

Calculate required screen length:

Assume 10 ft depth available.

Assume screens set at 60° from horizontal.

Screen Height = $10 / \sin 60^\circ = 11.55$ ft

Screen Length = $3,500 \text{ ft}^2 / 11.55 \text{ ft} = 303.1$ ft

Assume 1.0 ft structural member per 10 ft screen length

→ Total length = $303.1 \text{ ft} + 30 \text{ ft} = 333.1 \text{ ft}$ → Use 340 ft

Assume flat-plate screens cost \$1,000 per ft^2 , installed. This includes flow baffles, but does not include air-burst cleaning system.

Note: Further refinement of screen design should include an assessment of the information provided in an article by Metford and Sutphin (2007) regarding the impingement time and the maximum allowable approach velocity.

VALUE ENGINEERING ALTERNATIVE

Project: Lower Yellowstone River Irrigation Dam, Fish Protection and Passage

ALTERNATIVE NO: 5.2

PAGE NO: 1 OF 7

TITLE: Set headworks inland further to lessen amount of required cofferdam and decrease susceptibility of debris damage.

ORIGINAL DESIGN: This design describes building a new headworks inline with the bank, to obtain the required irrigation flow into canal.

PROPOSED DESIGN: This design describes building a headworks a “to be determined” distance from the bank to reduce cofferdam size and susceptibility to debris.

ADVANTAGES:

- This alternative could reduce the cost of the cofferdams by reducing the size of the cofferdam during construction.
- This alternative reduces the susceptibility to debris by having the screen out of the main river flow area.

DISADVANTAGES:

- This alternative could reduce the sweeping velocity.
- This alternative could have a greater possibility of sediment accumulation at the intake.
- This alternative could require more earth removal to accommodate the placement of the headworks.

COST ASSESSMENT SUMMARY:

COST SUMMARY	Present Worth Values For:				
	Initial CWE Costs	Replacement & Future Costs	Salvage Value	O&M Costs	Total Life Cycle Costs
Original Concept	\$70,000	\$0	\$0	\$0	\$70,000
Alternative Concept	\$16,000	\$0	\$0	\$0	\$16,000
Savings / (Expense)	\$54,000	\$0	\$0	\$0	\$54,000

Overall Performance Assessment: This proposed alternative would not alter the function of the base line design with respect to designed fish protection or water deliverability. It does allow for a lessened cofferdam size which in turn will decrease the cost associated with the construction of the cofferdam. Allowing for the screens to be placed outside the main river flow reduces the susceptibility of debris damage which will reduce the cost of repair or replacement. Sediment accumulation is a possible concern due to the reduced sweeping velocity.

DISCUSSION/JUSTIFICATION

One issue that has been discussed during this Value Engineering Study was the possible damage to the screens due to debris flowing down the river. One alternative to the base line concept is to have the headworks set slightly further inland to reduce the susceptibility of debris damage to the screens.

Screen size and screen location on the headworks will allow protrusion into the flow of the river with the headworks remaining inline with the river bank. This could create an opportunity for debris caught in the flow to impact the screens. This impact could possibly cause enough damage to make the screens non-operational or ineffective.

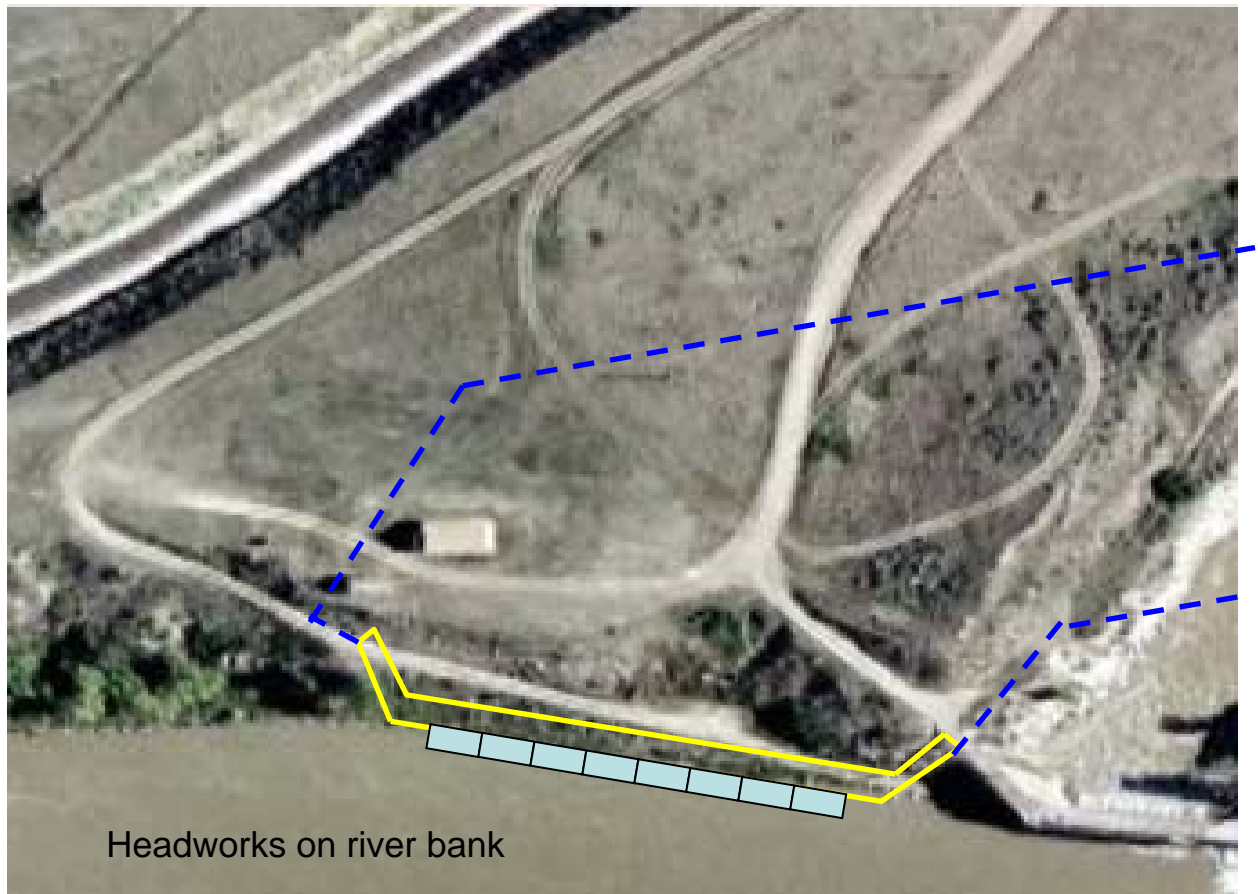
By insetting the headworks the screens will be in a position for greater protection by being outside the river flow. Removing screens from the debris field will prevent debris from lodging in the screen structure so cost will be decreased.

Constructing the headworks using this alternative also can also produce a lower cost of cofferdam construction. In the original design the new headworks will require a larger cofferdam that extends further into the river. Being able to set the headworks slightly inland will reduce the size in length and height of the cofferdam. While the cost associated with the smaller cofferdam will be lower, there is the possibility the cost well be slightly increased from extra earth excavation to accommodate the insetting the headworks.

While there are benefits to this design there is some concern about the amount of increased sediment from the decrease in sweeping velocity. Cost is associated with this as a maintenance issue as removal of the sediment would be needed.

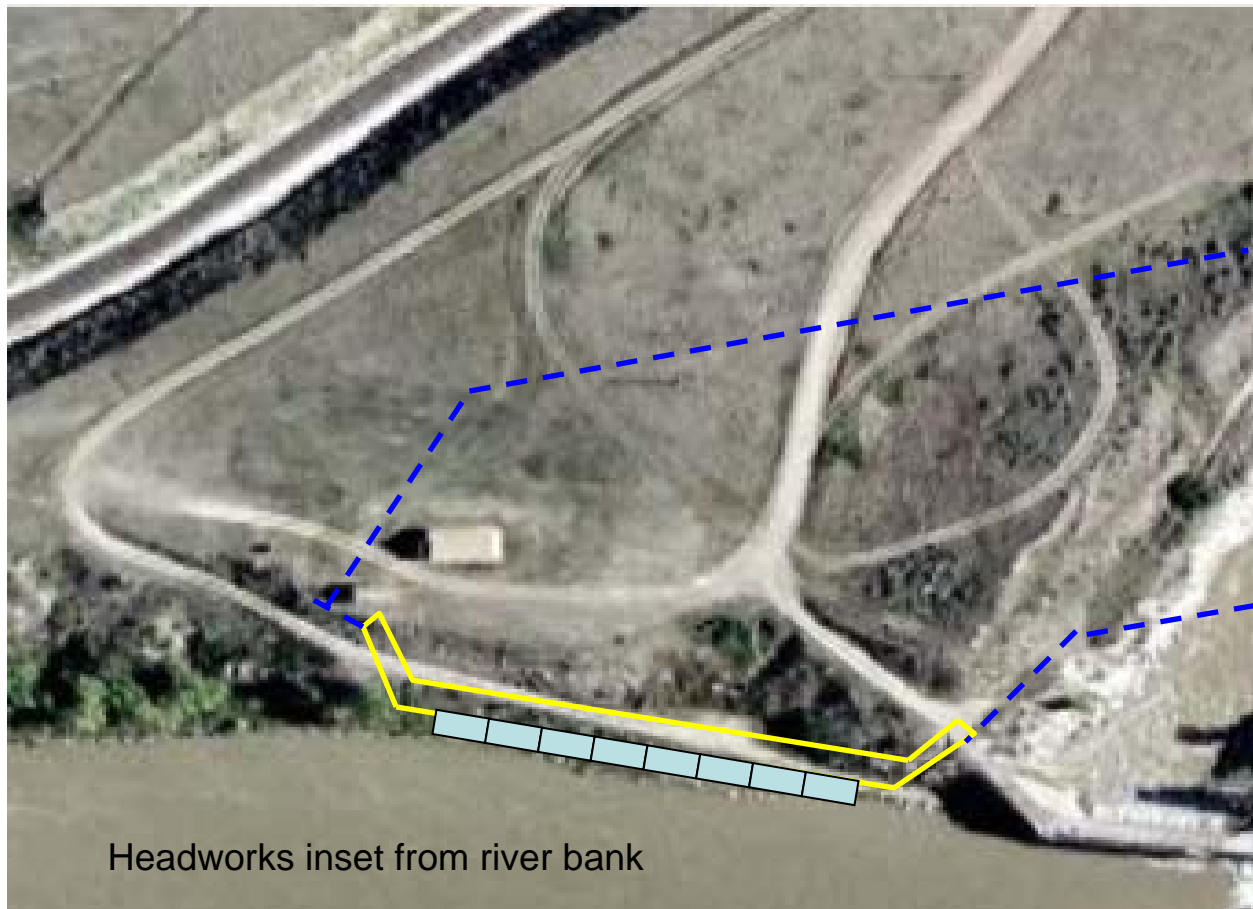
The concept of the new design in this study is to the lessen susceptibility of damage to the screens while providing the same functionality to the headworks. Keeping the pallid sturgeon out of the canal and keeping the required water flow are two important issues in this project. It is believed that this new alternative accomplishes both

DRAWING/SKETCH CURRENT DESIGN



This sketch not drawn to scale or to design specifications.

DRAWING/SKETCH PROPOSED IDEA



This sketch not drawn to scale or to design specifications.

PAGE NO: 5 OF 7

TITLE: Set headworks inland further to lessen amount of required cofferdam and decrease susceptibility of debris damage.

COST ANALYSIS – INITIAL COSTS

CONSTRUCTION ELEMENT		ORIGINAL CONCEPT			ALTERNATIVE CONCEPT		
Description	Unit	Quantity	Cost/Unit	Total	Quantity	Cost/Unit	Total
Construct and Remove Cofferdam	CY	1	\$46,584	\$46,584			\$0
Excavate and Haul Soil compaction factor 1.2	CY			\$0	3,477	\$3.05	\$10,598
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TOTAL CONSTRUCTION COST:				\$46,584			\$10,598
Owner Mark-Up Injcluding Contingency	50%			\$23,292			\$5,299
TOTAL CWE:				\$70,000			\$16,000
						SAVINGS	\$54,000

ASSESSMENT OF PERFORMANCE ATTRIBUTES

Fish Performance (FP): The sweeping velocity is an important part of the fish performance, not just a consideration for sediment. Especially for the submerged drum screen configuration, adequate sweeping velocity all around the screens is critical for acceptable performance and to satisfy screening criteria. Setting the screens back into the bank is to help protect from debris, but this will adversely affect fish performance, at least for the drum screen configuration.

Water Delivery Reliability (WDR): No significant change.

Engineering Design & Constructibility (EDC): This could decrease the size of the cofferdam. It could however increase earth removal to allow for placement of headworks.

Operations & Maintenance (O&M): Although there is a possibly a lessened susceptibility to debris there is a possibility of increase sediment accumulation. The reduced damage to screens may be offset by increase dredging of sediment.

Cost Effectiveness (CE): Decreasing the size of cofferdam would in effect reduce the cost associated with it. Reducing damage by removing

ASSUMPTIONS & CALCULATIONS

Estimated additional excavation for new headworks location:

Elevation Calculation to obtain volume

Elev 1: 1979 at 66 sq ft

Vol. = 12124

Elev 2: 2007 at 800 sq ft

Vol. = 12124

Elev 3: 1800 at 1800 sq ft

Vol. = 12124

Elev 4: 2040 at 66 sq ft

Total Vol. = 46950 sq ft = 1739 cu yd

Total Vol. both sides = 3477 cu yd

Assumption: Due to the fact that by moving the screens out of the main flow there will be a reduced cost in maintenance and the additional cost in dredging sediment the total maintenance cost will be the same.

VALUE ENGINEERING ALTERNATIVE

Project: Lower Yellowstone River Irrigation Dam, Fish Protection and Passage

ALTERNATIVE NO: 5.3

PAGE NO: 1 OF 7

TITLE: Install overshoot gates

ORIGINAL DESIGN: The baseline condition is the construction of a new headworks structure with rotating removable drum screens with irrigation canal extension. Further detail of this option is located in the 10 percent design report.

PROPOSED DESIGN: This alternative uses the v-shaped flat panel screen behind a headworks structure using overshoot gates to control the rate of diversion into the irrigation canal. The overshoot gates would replace the trashrack in the v-shaped screen option and would include the new headworks and irrigation canal extension from the removable drum screen option.

ADVANTAGES:

- Diverts water into the irrigation canal from top of the water column reducing the amount of sediment diverted which reduces canal maintenance
- Potentially reduces the amount larvae entrained into the irrigation canal
- Improves v-shaped screen entrainment protection option

DISADVANTAGES:

- Not preferred screen location
- Small risk of trapping an adult fish between diversion

COST ASSESSMENT SUMMARY:

COST SUMMARY	Present Worth Values For:				
	Initial Costs	CWE Replacement & Future Costs	Salvage Value	O&M Costs	Total Life Cycle Costs
Original Concept	\$14,874,000	\$0	\$0	\$0	\$14,874,000
Alternative Concept	\$23,091,000	\$0	\$0	\$0	\$23,091,000
Savings / (Expense)	(\$8,217,000)	\$0	\$0	\$0	(\$8,217,000)

Overall Performance Assessment:

The benefits of this alternative are marginal with high added project costs. This alternative is considered to be cost prohibitive.

DISCUSSION/JUSTIFICATION

The attraction of using overshot gates on the river headworks is water would be diverted from the top of the water column instead of the bottom of the water column as currently being done through the existing headworks with the high pressured gates. This would only be effective at the higher flows but higher flows usually coincide with the fish migration season.

The specific advantage is the pallid sturgeon is a river bottom fish. Diverting water from the top of the water column would reduce the likely hood of diverting the fish into the irrigation canal. The chance of diverting larvae into the irrigation canal would also be reduced.

Since fish would still be entrained into the irrigation canal, this would require a screen on the canal. The screening option used for this alternative is the v-shaped screen located on the canal. This would require the operation and maintenance of the headworks and the v-shaped screen.

This would improve irrigation canal maintenance since less sediment would be diverted into the canal. This would require less removal of sediment from the irrigation district distribution system.

During low flow, the gates would be wide open which would allow more trash and fish into the canal which would increase the maintenance associated with the v-shaped screen.

The existing headworks could not be modified to include overshot gates, so a new headworks structure would have to be constructed. Since the headworks would have to be constructed in the irrigation season, the headworks would be constructed upstream and would be similar to the baseline condition. It would be about a third of the length.

DRAWING/SKETCH PROPOSED DESIGN

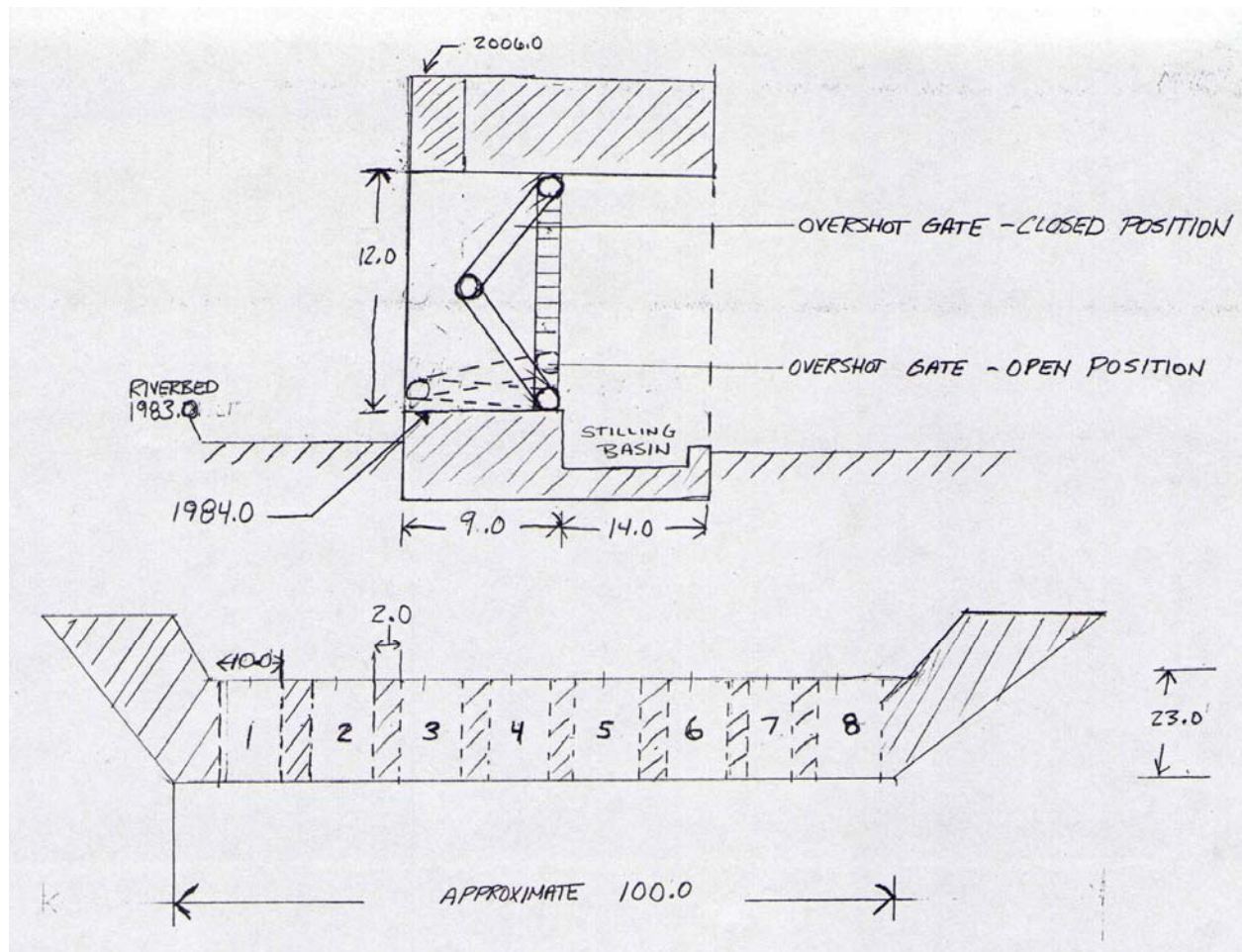


PHOTO OF PROPOSED IDEA



[illegible]

ASSESSMENT OF PERFORMANCE ATTRIBUTES

Fish Performance (FP): This alternative relies on the behavior of the pallid sturgeon. The intention of the alternative is to divert water from the top of the water column during the migration season and when larvae are drifting downstream pass the district's diversion. This relies on higher flows during the migration and larvae drift times. This could decrease the quantity of larvae entrained into the irrigation canal since larvae cannot be feasibly screened. Fish would not be exposed to high pressure gates. Note: Annual movement patterns could result in both adult and juvenile fishes being entrained during the lower water period when these gates would be down. Please review the Biological Review Team (2008) summary on why it is preferential to keep the fish out of the canal completely.

There is a chance an adult pallid sturgeon could pass the overshot gate. The adults would have to be screened out with any other fish in the v-shaped screen.

Water Delivery Reliability (WDR): Water management would improve with the ability to measure the quantity of water being diverted into the canal using the overshot gates.

Engineering Design & Constructibility (EDC): There is not a measurable change in the EDC for this alternative compared to the baseline alternative.

Operations & Maintenance (O&M): This alternative would reduce the quantity of sediment being diverted into the canal. This would reduce the amount of time the district would spend on sediment removal on routine canal maintenance.

An overshot gate on the river would be problematic in the ice conditions.

The v-shaped screen and the headworks would have to be maintained.

Cost Effectiveness (CE): This would require the v-shaped screen in addition to the new headworks and irrigation canal extension. This alternative costs significantly more than baseline alternative.

ASSUMPTIONS & CALCULATIONS

Assumptions

- Headworks Structure with Overshot Gates
- Velocity of water entering canal over the overshoot gates: 2.5 cubic-feet per second (cfs) [Note: the burst swim speed for juvenile sturgeon is about 0.4-0.7 m/s (1.3-2.2 fps)]
- Current dam elevation: 1989.0 feet
- 1 foot head loss through v-shaped screen
- River water surface elevation at 3,000 cfs flowrate in the river: 1991.0 feet
- River water surface elevation at 40,000 cfs flowrate in the river: 1996.0 feet
- Headworks sill elevation: 1975.0 feet
- Riverbed elevation: 1983.0 feet
- Gate sill elevation: 1984.0 feet
- Top of headworks: 2006.0 feet (same as baseline)
- Gates cost \$700 per square-foot and gates are 170 square-feet

Calculations

V = Velocity

A = Area

Q = Flow

$$Q = V * A = 1400 = 2.5 * A$$

$$A = 560 \text{ ft}^2$$

Water surface elevation@ 3000 cfs = 1991 feet

Bottom sill of gates – elevation = 1984.0 feet

Water depth available is $1991 - 1984 = 7$ feet

$$A = \text{depth} * \text{width} = 560 = 7 * \text{width}$$

$$\text{Width} = 80 \text{ feet}$$

Use eight 10 feet overshoot gates [NOTE: If a velocity of 2.3 fps is used, nine gates would be required]

$$\text{Gate opening is } 12.0 \text{ feet} = 1996.0 - 1984.0$$

$$\text{Gate length required with } 45 \text{ degree opening (max)} = 17 \text{ feet gate}$$

VALUE ENGINEERING ALTERNATIVE

Project: Lower Yellowstone River Irrigation Dam, Fish Protection and Passage

ALTERNATIVE NO: 6.0

PAGE NO: 1 OF 5

TITLE: Construct low flow channel in ramp out of concrete, gunite, or grout to fix location

ORIGINAL DESIGN: Baseline design utilizes quarry stone riprap with 24-in D₁₀₀. Rock ramp at a 1% slope requires 223,000 Ton of rock (135,152 cy). Assumed length of the rock ramp is 1,000 feet (1% slope on 10 ft high dam), and channel width is approximately 700 width.

PROPOSED DESIGN: Utilize shotcrete/gunite on the top of the rock ramp to provide stability to the rock to resist high flow and ice forces. This alternative includes evaluation of shotcrete and grout as options.

ADVANTAGES:

- Long-term stability and maintenance should be improved at least in the short term.

DISADVANTAGES:

- Concern about freeze – thaw cycling and durability. Pore pressure concerns under low flow and whether cap would “float” out of shape.
- Adaptive management becomes challenging if the slope and or channel width would need to be adjusted based on monitoring for success.

COST ASSESSMENT SUMMARY:

COST SUMMARY	Present Worth Values For:				
	Initial Costs	CWE Replacement & Future Costs	Salvage Value	O&M Costs	Total Life Cycle Costs
Original Concept	\$0	\$0	\$0	\$0	\$0
Alternative Concept	\$1,333,000	\$0	\$0	\$0	\$1,333,000
Savings / (Expense)	(\$1,333,000)	\$0	\$0	\$0	(\$1,333,000)

Overall Performance Assessment:

Although this alternative concept appears to have short-term benefits there are big questions about long-term durability under ice loading and freeze-thaw cycles. A big component of the project is monitoring for success and adaptively managing performance, if necessary, by changing the ramp geometry. Utilization of shotcrete or grout to stabilize the rock limits the ability to make changes after construction.

DISCUSSION/JUSTIFICATION

One major concern for this project is stability of any feature during high flows and ice conditions. One critical feature of the rock ramp for fish passage is the incorporation of one or more low flow channels. The low flow channels would provide depth and flow conditions to allow passage under low flow conditions. Since these channels are smaller and inset into the ramp surface they may be more vulnerable to rock movement. This proposal would increase durability and stability by utilizing a shotcrete laminate within these channels. The shotcrete would include fiber reinforcement to increase strength.

It is hoped that this approach would better resist ice forces and relocation of surface material that might otherwise block the low flow channel impeding migration of the pallid sturgeon and increasing the need for additional maintenance.

However, there are some inherent problems with grouting or guniting the rock surface. The current plan is to apply an adaptive management approach which would allow altering the conditions of the ramp to better meet fish passage needs following several years of monitoring. Stabilizing the low flow channel would limit adaptive management options if the project would need to be modified after monitoring. Lack of ability to adaptively manage could be a challenge.

Additionally, there is a potential issue of uplift pressures that could dislodge the concreted cap unless some type of pressure relief system was included. Finally, there is some concern that the concrete will deteriorate over a fairly short time span, say 10 to 15 years, requiring expensive replacement.

ALTERNATIVE NO: 6.0 **PAGE NO: 3 OF 5**

PAGE NO: 3 OF 5

TITLE: Construct low flow channel in ramp out of concrete, gunite, or grout to fix location

COST ANALYSIS – INITIAL COSTS

[illegible]

ASSESSMENT OF PERFORMANCE ATTRIBUTES

Fish Performance (FP): On the positive side, the low flow channel would be fixed and resist blocking making fish passage easier. On the negative side, adaptive management may be impeded.

Water Delivery Reliability (WDR): No significant impact.

Engineering Design & Constructibility (EDC): Design and construction is complicated by this added ramp component.

Operations & Maintenance (O&M): Near-term O&M reduction, but long-term could be expensive for replacement after damage/cracking.

Cost Effectiveness (CE): Overall increase in cost.

ASSUMPTIONS & CALCULATIONS

Total surface area of the ramp = 700 ft * 1,000 ft = 700,000 sq.ft. = 77,780 sq. yd.

Assume cost prohibitive to shotcrete/grout entire ramp. Explore costs for a 100 ft. wide low flow channel.

Volume 100 ft * 1,000 ft * 1ft = 3,704 cy

1.5 ft = 5,556 cy

2.0 ft = 7,407 cy

VALUE ENGINEERING ALTERNATIVE

Project: Lower Yellowstone River Irrigation Dam, Fish Protection and Passage

ALTERNATIVE NO: 7.1

PAGE NO: 1 OF 7

TITLE: Consider a layered material (including field stone) system for ramp

ORIGINAL DESIGN: The ramp was constructed entirely of a quarried rock and not zoned or layered with different materials.

PROPOSED DESIGN: Construct ramp with a layered system, a system of rock underlain by a geotextile and that underlain with earthfill from excavation of new headworks irrigation canal. Another alternative would be the use of field stone in lieu of the excavated soil.

ADVANTAGES:

- Current estimate considers only rock for 1% slope ramp
- Would reduce cost
- Good place to waste excess material
- Protected by quarry stone
- Locally available
- Low cost material

DISADVANTAGES:

- Ramp maintenance may be more difficult.

COST ASSESSMENT SUMMARY:

COST SUMMARY	Present Worth Values For:				
	Initial Costs	CWE Replacement & Future Costs	Salvage Value	O&M Costs	Total Life Cycle Costs
Original Concept	\$13,380,000	\$0	\$0	\$320,000	\$13,700,000
Alternative Concept	\$8,584,000	\$0	\$0	\$320,000	\$8,904,000
Savings / (Expense)	\$4,796,000	\$0	\$0	\$0	\$4,796,000

Overall Performance Assessment:

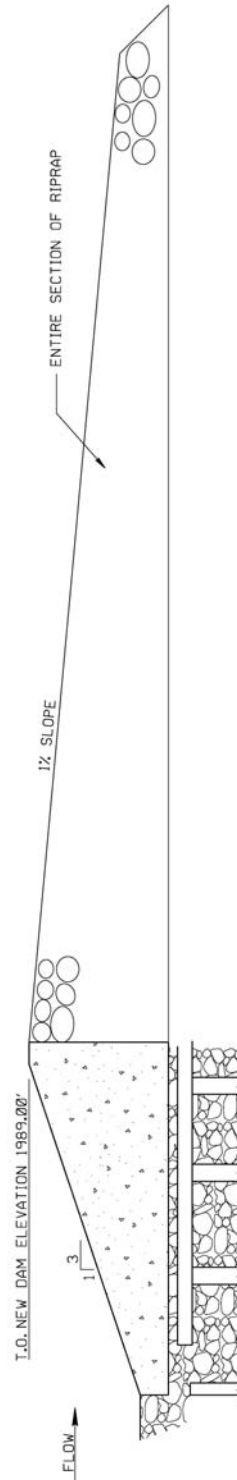
This alternative did not affect the upstream area of the ramp or the headworks. The performance of the project should be the same if not better than the current design.

DISCUSSION/JUSTIFICATION

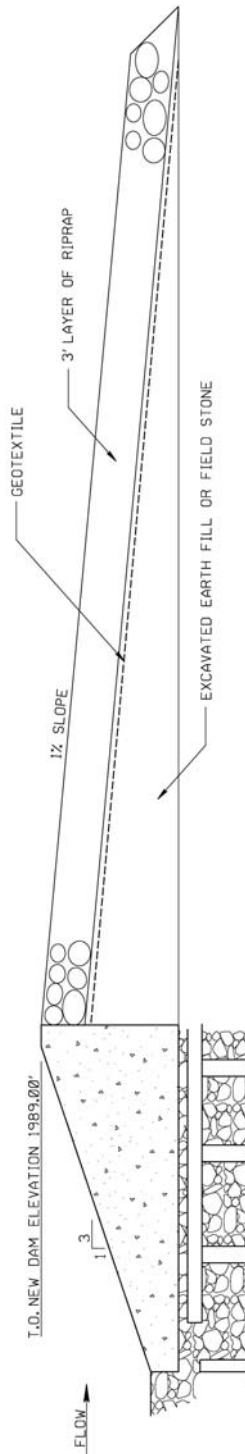
The effective use of on-site excavated material as a foundation for the rock ramp material is logical. Also, the resulting reduction in imported rock is logical. Any movement of rock due to ice is a minor risk to this alternative while using the 3-foot thick rock layer. The risk is the rock layer is moved, the geotextile is ripped and the soil subbase is eroded and more drastic rock movement occurs. This will be limited by the correct combination of rock size, layer thickness, and ramp slope.

If field stone is utilized as the base rock this would be less of a savings, but would ultimately be better in overall or long-term stability.

DRAWING/SKETCH CURRENT DESIGN



DRAWING/SKETCH PROPOSED IDEA



ALTERNATIVE NO: 7.1 PAGE NO: 5 OF 7
TITLE: Consider a layered material (including field stone) system for ramp

ALTERNATIVE NO: 7.1 PAGE NO: 5 OF 7
TITLE: Consider a layered material (including field stone) system for ramp

ASSESSMENT OF PERFORMANCE ATTRIBUTES

Fish Performance (FP): The fish passage should be similar to the original design since the ramp surface was not changed other than possibly smoothing the ramp.

Water Delivery Reliability (WDR): This alternative would not affect the water delivery.

Engineering Design & Constructibility (EDC): The overall constructability would be improved by the firm base provided by the fine grained fill.

Operations & Maintenance (O&M): The O&M would be similar to the original design. Any changes in the ramp during its performance may be limited by the 3' layer of rock.

Cost Effectiveness (CE): The cost savings would be increased greatly as shown in the analysis. The use of the excavated soil in the new headworks canal reduces the cost positively.

ASSUMPTIONS & CALCULATIONS

Used a straight-line geometry for the calculation cross section.

Riprap:

$$724,966 \text{ ft}^2 \times 3 \text{ ft.} = 2,174,898 \text{ ft}^3 = 80550 \text{ yd}^3 = 132,910 \text{ Tons}$$

Geotextile:

$$724,966 \text{ ft}^2 / 9 = 80,551 \text{ yd}^2$$

Earthwork:

$$100,000 \text{ yd}^3$$

VALUE ENGINEERING ALTERNATIVE

Project: Lower Yellowstone River Irrigation Dam, Fish Protection and Passage

ALTERNATIVE NO: 7.2

PAGE NO: 1 OF 7

TITLE: Use soil-filled Geotubes to create a portion of the ramp

ORIGINAL DESIGN: The original design is based on creating a 1% ramp slope directly downstream of the existing Irrigation Dam. The original design also proposes placement of a concrete weir (plug) directly upstream of the existing Irrigation Dam. In order to meet the 1% slope of the ramp would require 140,000 CY of additional rock. The concrete weir (plug) requires 4,000 CY of concrete.

PROPOSED DESIGN: The proposed design would utilize excavated material from the new headwall channel to fill Geotubes. The Geotubes will be used as filler to reduce the volume of rock and concrete required. The remaining volumes could use rock and concrete at the surface. This proposal could potentially reduce the rock and concrete volumes in half. Therefore, half of the volume would be soil-filled Geotubes and the other volume half would be rock and concrete.

ADVANTAGES:

- Uses less rock
- Reduce cost
- May reduce construction duration
- Will be able to construct in the wet

DISADVANTAGES:

- The soil-filled Geotubes could experience some displacement
- Soil conditions could restrict filling of Geotubes. If rock is encountered during dredging.

COST ASSESSMENT SUMMARY:

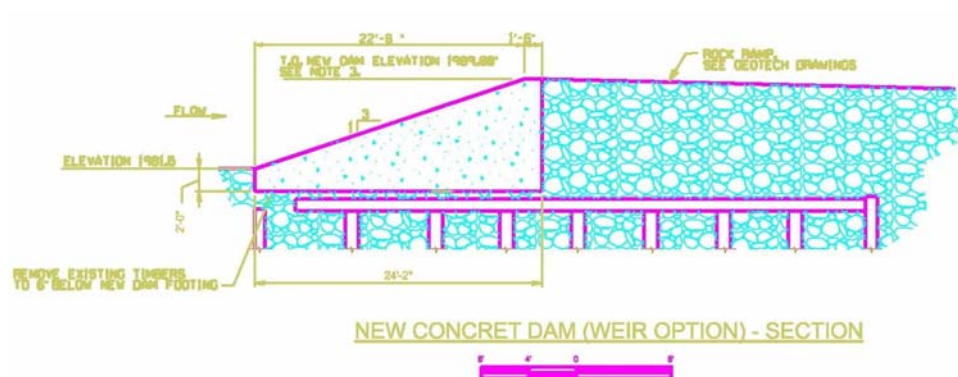
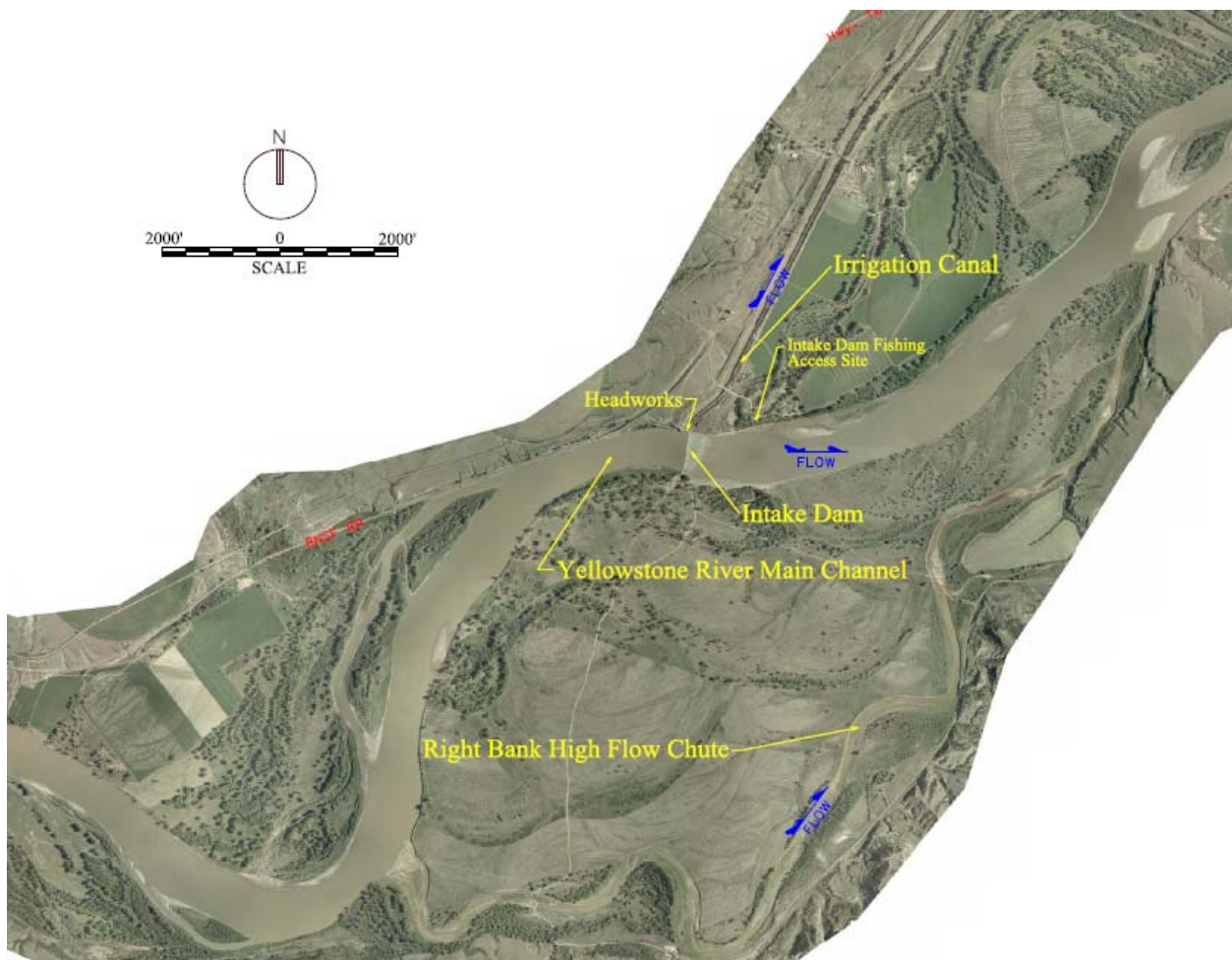
	Present Worth Values For:					
COST SUMMARY	Initial Costs	CWE	Replacement & Future Costs	Salvage Value	O&M Costs	Total Life Cycle Costs
Original Concept	\$15,647,000		\$0	\$0	\$0	\$15,647,000
Alternative Concept	\$9,915,000		\$0	\$0	\$0	\$9,915,000
Savings / (Expense)	\$5,732,000		\$0	\$0	\$0	\$5,732,000

Overall Performance Assessment: This proposal has good potential if soil conditions prove to be favorable for dredging.

DISCUSSION/JUSTIFICATION

Utilizing the excess soil excavated from the new Headwall Channel reduces cost and utilizes onsite material more effectively. The use of Geotubes to build the ramp base would allow construction under both wet and dry conditions. If construction is conducted in the water, construction options become more limited to construction methods such as Geotubes. If construction requires or allows for dry conditions, construction of other alternatives may be comparably cost effective. Examples of dry condition construction would be mechanically excavating soil from the Headwall Channel or the use of field stone as a ramp material base. See Alternative 7.1.

DRAWING/SKETCH CURRENT DESIGN



COST ANALYSIS – INITIAL COSTS

CONSTRUCTION ELEMENT		ORIGINAL CONCEPT			ALTERNATIVE CONCEPT		
Description	Unit	Quantity	Cost/Unit	Total	Quantity	Cost/Unit	Total
				\$0			\$0
Quarried Rock	Ton	223,000	\$41	\$9,143,000			\$0
Excavated Soil	CY	100,720	\$3.60	\$362,592			\$0
Excavated Rock	CY	103,000	\$4.81	\$495,430			\$0
Concrete Weir (4,013 CY of Concrete)	LS			\$0			\$0
Diversion of Water	LS	1	\$430,000	\$430,000			\$0
				\$0			\$0
				\$0			\$0
				\$0			\$0
Quarried Rock	Ton			\$0	111,500	\$41	\$4,571,500
Dredge/Fill Geotubes	CY			\$0	72,000	\$20	\$1,440,000
Excavated Soil	CY			\$0	28,720	\$3.60	\$103,392
Excavated Rock	CY			\$0	103,000	\$4.81	\$495,430
Concrete Weir (4,013 CY of Concrete)	LS			\$0			\$0
				\$0			\$0
				\$0			\$0
				\$0			\$0
				\$0			\$0
				\$0			\$0
				\$0			\$0
				\$0			\$0
TOTAL CONSTRUCTION COST:				\$10,431,022			\$6,610,322
Owner Mark-Up Including Contingency	50%			\$5,215,511			\$3,305,161
TOTAL CWE:				\$15,647,000			\$9,915,000
					SAVINGS		\$5,732,000

ASSESSMENT OF PERFORMANCE ATTRIBUTES

Fish Performance (FP): No significant impact.

Water Delivery Reliability (WDR): No significant impact.

Engineering Design & Constructibility (EDC): Engineering should be straight forward and construction should be simplified with the ability to construct in the wet.

Operations & Maintenance (O&M): Maintenance may be an issue if Geotubes are displaced.

Cost Effectiveness (CE): Cost can be significantly reduced by while utilizing excess soil in lieu of imported materials.

ASSUMPTIONS & CALCULATIONS

Current Design:

140,000 CY Rock or 223,000 Ton

Proposed:

Assume 70,000 CY or half of the volume for filling the Geotubes

Production Rate:

Assume (150 CY/Hr), 24/7:

$(70,000 \text{ CY}) / (150 \text{ CY / Hr}) = 467 \text{ Hrs}$
 $(467 \text{ Hrs.}) / (24 \text{ Hrs/Day}) = 20 \text{ Days}$
With Mob/Demob Assume (1) Month

VALUE ENGINEERING ALTERNATIVE

Project: Lower Yellowstone River Irrigation Dam, Fish Protection and Passage

ALTERNATIVE NO: 7.3

PAGE NO: 1 OF 6

TITLE: Build ramp to ~90% complete in the wet and complete in low flow season

ORIGINAL DESIGN: Original design included rock ramp construction in the dry using coffer dams.

PROPOSED DESIGN: The rock ramp would be constructed in stages. The initial construction stage would build the ramp up to a level about 3 feet below finished grade while in the wet during the low flow period (normally August through March). The second phase would finish the ramp in the dry with a low level coffer dam in the low flow period.

ADVANTAGES:

- Eliminate cofferdam, could divert water around work area with a much smaller profile structure such as geotubes or sand bags without requiring dewatering

DISADVANTAGES:

- a. Would have seasonal restrictions on rock placement to avoid the high flow season or the migratory season
- May be issues with placement in the wet, would need approval from DEQ and USFWS, also may need additional fish protection during construction

COST ASSESSMENT SUMMARY:

COST SUMMARY	Present Worth Values For:				
	Initial CWE Costs	Replacement & Future Costs	Salvage Value	O&M Costs	Total Life Cycle Costs
Original Concept	\$645,000	\$0	\$0	\$0	\$645,000
Alternative Concept	\$88,000	\$0	\$0	\$0	\$88,000
Savings / (Expense)	\$557,000	\$0	\$0	\$0	\$557,000

Overall Performance Assessment:

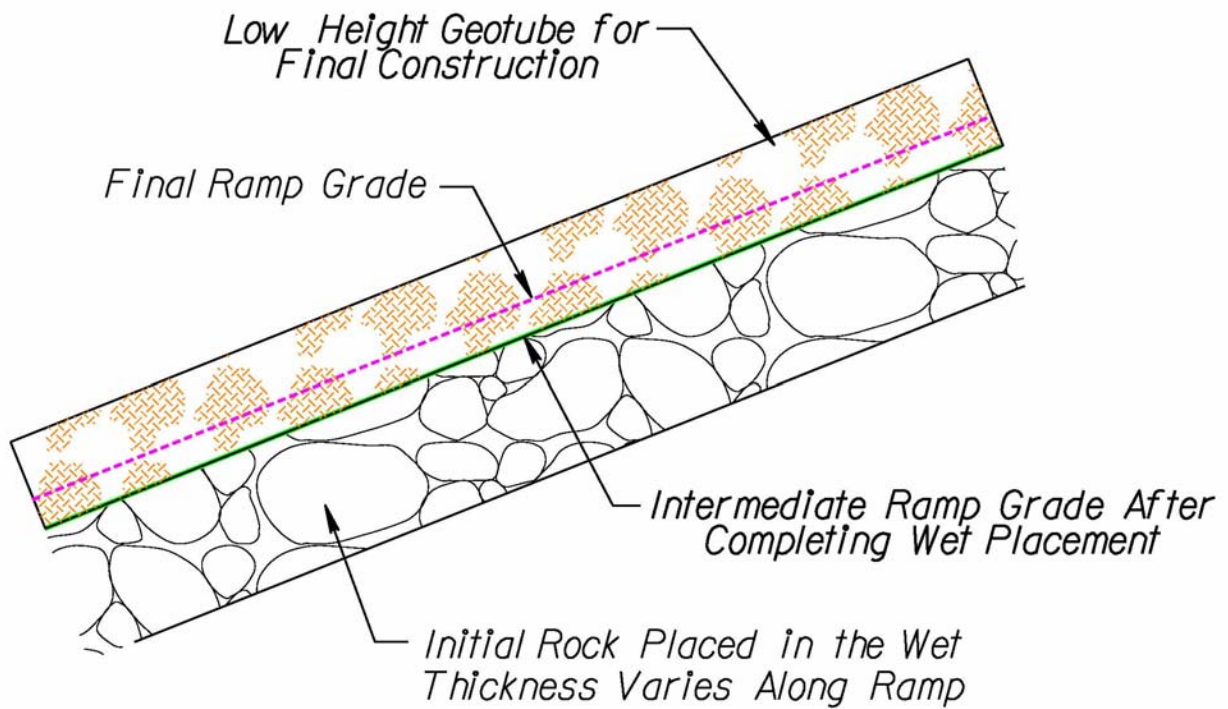
The key factor to this proposal is the ability to achieve the final finished grade to the required tolerance. The base condition assumes all construction in the dry to achieve good placement thickness and final finished grade. By placing the rock initially in the wet for the bottom portion of the ramp followed by dry final grade placement, the quality should be comparable.

DISCUSSION/JUSTIFICATION

The proposal appears to be reasonable without sacrificing final product quality. Based on experience with other ramps, complete placement in the wet resulted in unsatisfactory quality. This proposal achieves cost savings by combining both wet and dry placement. The final ramp slope and rock placement quality should be similar to the base condition.

Cost savings were generated by using a very low head Geotube (assumed 3 feet in height) instead of the cofferdam to provide dry conditions for the final finished grade placement. The dewatering cost was also reduced significantly due to a shortened time period and the smaller pipe length.

DRAWING/SKETCH PROPOSED DESIGN



[illegible]

ASSESSMENT OF PERFORMANCE ATTRIBUTES

Fish Performance (FP): No significant impact if construction quality is maintained.

Water Delivery Reliability (WDR): No significant impact.

Engineering Design & Constructibility (EDC): Should be improved since the dewatering and coffer dam issues are simpler.

Operations & Maintenance (O&M): No significant impact.

Cost Effectiveness (CE): Provides reasonable cost savings.

ASSUMPTIONS & CALCULATIONS

The low level coffer dam would be built with a Geotube or similar feature to keep flowing water off the ramp. Geotube cost assumed as \$20/cu yd. Geotube volume was based on length of 2400 feet to cover the length of the ramp and $\frac{1}{2}$ of the river. The volume may be conservative as the entire ramp probably wouldn't need a Geotube of the 3 foot height. This gives an approximate Geotube volume of 630 cubic yards.

Also assumed that minor dewatering would be required at the downstream end of the ramp due to seepage. Used a pipe length of only 100 feet, assumed the same pump as base line with reduced operating hours from 2500 to 720 (about $\frac{1}{3}$). Reduced the skilled labor hours from 1000 to 100 due to ease of operation and shorter period.

VALUE ENGINEERING ALTERNATIVE

Project: Lower Yellowstone River Irrigation Dam, Fish Protection and Passage

ALTERNATIVE NO: 8.0

PAGE NO: 1 OF 7

TITLE: Utilize synthetic materials to construct ramp

ORIGINAL DESIGN: The original design is based on creating a 1% ramp slope directly downstream of the existing Irrigation Dam. In order to meet the 1% slope of the ramp would require 140,000 CY or 223,000 Ton of additional rock.

PROPOSED DESIGN: The proposed design recommends using a Concrete Cellular Mattress surface with a Geotube base in lieu of a solid quarried rock cross-section.

ADVANTAGES:

- Creates a more uniform surface

DISADVANTAGES:

- Too Costly

COST ASSESSMENT SUMMARY:

	Present Worth Values For:					
COST SUMMARY	Initial Costs	CWE	Replacement & Future Costs	Salvage Value	O&M Costs	Total Life Cycle Costs
Original Concept	\$14,256,000		\$0	\$0	\$0	\$14,256,000
Alternative Concept	\$48,300,000		\$0	\$0	\$0	\$48,300,000
Savings / (Expense)	(\$34,044,000)		\$0	\$0	\$0	(\$34,044,000)

Overall Performance Assessment: This alternative is too costly to be used for the entire ramp surface but may be considered for small areas if applicable. This alternative is considered to be cost prohibitive.

DISCUSSION/JUSTIFICATION

This alternative is too costly to be used for the entire ramp surface but may be considered for small areas if applicable.

DRAWING/SKETCH CURRENT DESIGN



DRAWING/SKETCH PROPOSED IDEA



COST ANALYSIS – INITIAL COSTS

CONSTRUCTION ELEMENT		ORIGINAL CONCEPT			ALTERNATIVE CONCEPT		
Description	Unit	Quantity	Cost/Unit	Total	Quantity	Cost/Unit	Total
				\$0			\$0
Quarried Rock	Ton	223,000	\$41	\$9,143,000			\$0
Excavated Soil	CY	100,000	\$3.61	\$361,000			\$0
				\$0			\$0
				\$0			\$0
Concrete Cellular Mattress	SF			\$0	880,000	\$35	\$30,800,000
Dredge/Fill Geotubes	CY			\$0	70,000	\$20	\$1,400,000
				\$0			\$0
				\$0			\$0
TOTAL CONSTRUCTION COST:				\$9,504,000			\$32,200,000
Owner Mark-Up Including Contingency	50%			\$4,752,000			\$16,100,000
TOTAL CWE:				\$14,256,000			\$48,300,000
					SAVINGS		-\$34,044,000

ASSESSMENT OF PERFORMANCE ATTRIBUTES

Fish Performance (FP): Surface roughness would be different then that obtained with rock, which would impact velocities. This needs to be accounted for in the design and modeling.

Water Delivery Reliability (WDR): No significant impact.

Engineering Design & Constructibility (EDC): No significant impact.

Operations & Maintenance (O&M): This design may function well in the short term but long term is questionable.

Cost Effectiveness (CE): This proposal would be too costly.

ASSUMPTIONS & CALCULATIONS

Surface Area: 800' W x 1,100' L = 880,000 SF

Assume: Concrete Cellular Mattress at 1' – 3" Deep, 185 lbs/SF.

Assume: Concrete Cellular Mattress will account for 40,000 CY of the required 140,000 CY of volume required to meet the 1% ramp slope.

Assume: The remaining 100,000 CY of volume could be achieved by the use of Geotubes

VALUE ENGINEERING COMMENTS

INTRODUCTION

In addition to the VE Alternatives presented above, the VE team developed a series of comments or suggestions to support meeting the Federal project objectives for the Lower Yellowstone River Irrigation Dam, Fish Protection and Passage Project. These suggestions present ideas generated by the team that are felt to add value to the project. The VE team encourages the Project Development Team to consider these comments for opportunities to improve the quality of the project. The reader may also find that a review of the comments presented herein will awaken new and/or modified ideas that they may wish to investigate further or implement.

DESIGN COMMENTS

Presented below are the comments put forth by the VE team. It should be noted that, where commonality of thought prevails, speculation ideas have been combined into a single comment.

1. Consult with Walla Walla District for write-ups regarding available fish screens; multiple sources for cylindrical screens; alternate cleaning systems (Creative Idea No. 6, 70 & 105) -

There are many different fabricators or manufacturers of screening systems. Some have proprietary patented components, but there are several that will satisfy project specifications and fish protection criteria. Likewise, there are different types of screen configurations and screen cleaning systems that could work for this application. As part of the design process, rather than looking at just a given screening system or a sole source provider for the screens, it is a good idea to investigate multiple sources and consider the pros and cons of several different screening systems.

Walla Walla District (NWW) engineers have extensive experience in both fish passage and screening. Consulting with NWW will take advantage of their expertise, experience, and contacts. This will likely save time and effort while resulting in a better final product.

(Performance Attributes)

Fish Performance (FP): No change from baseline as long as the screens are designed to meet NOAA Fisheries criteria.

Water Delivery Reliability (WDR): Likely no change from baseline unless a different screening system is identified through this process that is more reliable.

Engineering Design & Constructibility (EDC): Takes advantage of NWW design experience, expertise, and contacts, resulting in more efficient design.

Operations & Maintenance (O&M): May result in a more efficient system, which minimizes operation and maintenance requirements.

Cost Effectiveness (CE): Should result in a more efficient design process, and overall better value.

2. Identify best value for fish screen (Creative Idea No. 15) -

There are multiple types of fish screening systems and configurations, and many different potential manufacturers, fabricators, or sources. Considering the full spectrum of possibilities will result in the best overall value.

(Performance Attributes)

Fish Performance (FP): Ensures the best method for protecting the fish from being entrained in the diversion.

Water Delivery Reliability (WDR): Likely no change from baseline unless a different screening system is identified through this process that is more reliable.

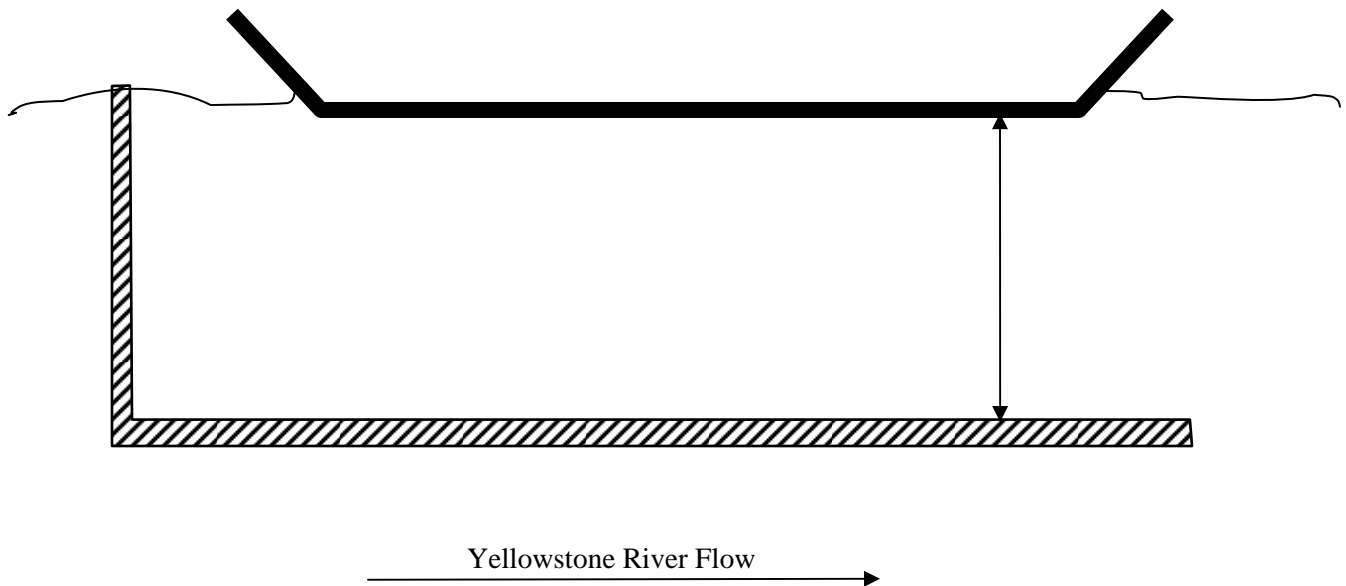
Engineering Design & Constructibility (EDC): Identifies the most efficient process for both design and construction.

Operations & Maintenance (O&M): Results in the most efficient system, which minimizes operations and maintenance requirements.

Cost Effectiveness (CE): The whole point is to identify the best value, which inherently maximizes the cost effectiveness.

3. Incorporate fish guidance structure (i.e. bottom mounted curtain or concrete wall) to divert fish away from intake structure by diverting higher in the water column (Creative Idea No. 20 & 108) -

Including a low wall (3 to 4 feet high) out in front of the fish screen would not impact water flow/delivery to the screens but may provide big advantages in keeping the pallid sturgeon larval away from the screens reducing entrainment and impingement risks. The wall may also serve to divert bedload sediments away from the screens increasing longevity of the screens and possibly reducing O&M. Leaving the wall open on the downstream side would allow for sediments to be swept out of the channel. Keeping the wall low should keep it below impact of most ice but top elevation would need to be optimized through hydraulic modeling.



(Performance Attributes)

Fish Performance (FP): Potential significant improvement by reducing number of fish carried through the screens into the irrigation channel.

Water Delivery Reliability (WDR): No significant impact, though water quality may improve through a reduction in sediment.

Engineering Design & Constructibility (EDC): The fish guidance structure would represent an added component for design and construction.

Operations & Maintenance (O&M): No significant impact, although sediment accumulation in the irrigation channel may be reduced.

Cost Effectiveness (CE): There would be an added initial cost to the project.

4. Build a pallid sturgeon education facility on site (Creative Idea No. 26)-

An onsite pallid sturgeon education facility would provide information to the public about the importance of protecting this endangered species and how the Intake dam modification project was designed to meet this need. The facility would focus on the life cycle of the pallid sturgeon, but would also provide information on other native species within the Lower Yellowstone River system. The education center could also be used to mitigate for impacts to the fishing access site.

(Performance Attributes)

Fish Performance (FP): No significant impact.

Water Delivery Reliability (WDR): No significant impact.

Engineering Design & Constructability (EDC): No significant impact.

Operations & Maintenance (O&M): Some sign maintenance and updating of information may be needed.

Cost Effectiveness (CE): Minor cost impact.

5. Utilize series of wedge-shaped grade control structures (concrete, sheet pile sills) as part of a rock ramp for stability (Creative Idea No. 46) -

The stability of the rock ramp is paramount to achieve fish performance and water delivery reliability. The base condition rock ramp does not include any grade control features but relies simply on the rock itself to resist erosion, ice, and other displacement forces. During the life of the ramp, it is likely that one or more extreme events will occur. Therefore, the inclusion of grade control structures, while adding cost, is probably justified to lower the risk of ramp performance failure. Grade control performance could be achieved by inserting a series of sills perpendicular to the ramp. The sills could be constructed of many different components such as a concrete, sheet pile, or even large derrick size stone.

During the hydraulic analysis and physical model of the ramp, the velocity and rock displacement forces should be estimated. The ice displacement forces should also be estimated.

For a rough cost comparison, using the relocate main channel cost estimate that included rock sills, the average cost per sill was about \$300,000. Adding four sills would cost about \$1 to \$1.5 million. The additional sill cost would be offset by less ramp rock.

Ramp stability should be thoroughly investigated with the hydraulic numeric and physical modeling efforts for a full range of flow events. If questions regarding ramp stability are identified, then sills should be incorporated to insure long term ramp stability and fish performance.

(Performance Attributes)

Fish Performance (FP): The sills could be an important factor to assure long term performance. However, the sills could also be a detriment to passage depending on sill height. If erosion occurs on the downstream sill edges, you would effectively have a "step" type ramp.

Water Delivery Reliability (WDR): None. The sills should not impact the reliability of the concrete dam crest.

Engineering Design & Constructibility (EDC): Design and constructability are both slightly impacted due to the added complexity of the sills.

Operations & Maintenance (O&M): O&M costs are reduced since the ramp reliability is increased.

Cost Effectiveness (CE): A cost increase of \$1 to \$1.5 million may be added depending on number of sills.

6. Incorporate a canoe/float/kayak run into the rock ramp design (Creative Idea No. 46) -

Although not a primary project component, recreation interests could be considered in this project. Currently, there is a boat ramp below the dam that may be impacted by the project and will need to be addressed. An added recreational benefit might be the use of the rock ramp as a man-made sport canoe/float/kayaking run, similar to other facilities available to boating enthusiasts (see photos below). Boulders would be used to create a path for users over the rock ramp and dam. This use could garner support for the project from recreational community

Disadvantages include increased cost as an added feature of the rock ramp, and the potential safety hazard during extreme high and low flows. The project would need to include safety features such as buoys and signage and ensure kayak river access.



(Performance Attributes)

Fish Performance (FP): Kayakers want white water, yet it is this type of turbulence that appears to be troublesome for pallid sturgeon. Adding a Kayak park will increase uncertainty to the project from a passage stand point.

Water Delivery Reliability (WDR): No significant change.

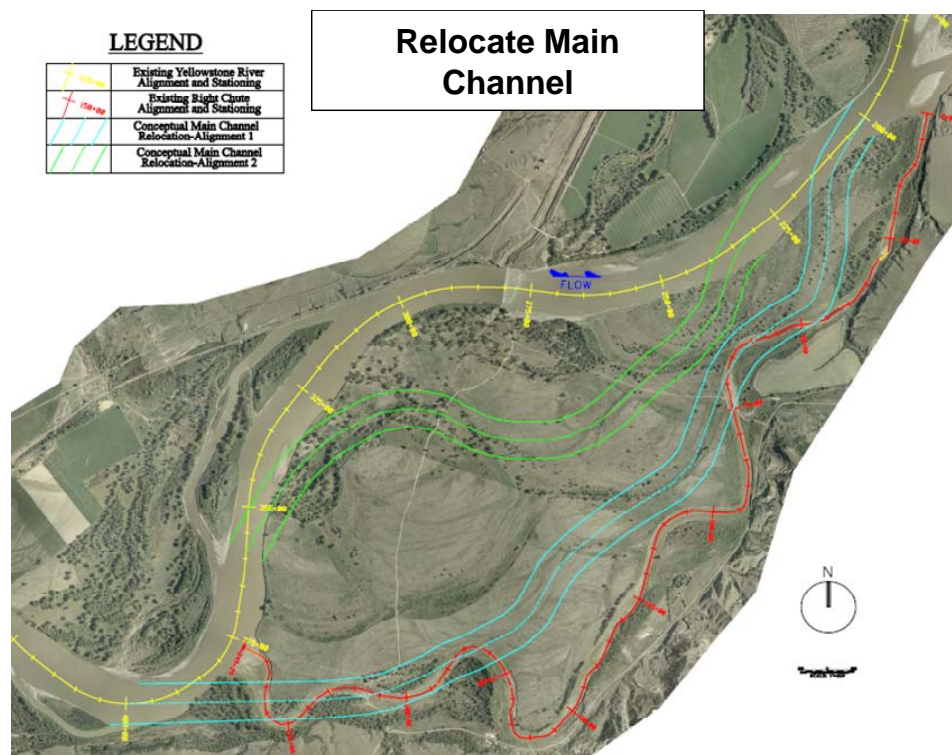
Engineering Design & Constructibility (EDC): Rock ramp would need to include the kayak run as an extra feature. Would need to ensure that the kayak run was designed in a way that wouldn't create velocities and turbulence that exceed pallid sturgeon swim tolerance.

Operations & Maintenance (O&M): No significant change.

Cost Effectiveness (CE): Construction of a kayak run into the rock ramp would increase construction costs.

7. Replace rock ramp with downstream bypass side channel (relocate river)
(Creative Idea No. 60) -

This proposal, which is one of the original six alternatives being considered by the PDT, would move the main channel of the Yellowstone River from its current location to bypass the existing intake Diversion Dam (see figure below). The relocated channel would be 12,500 ft and have a steeper slope than the natural riverbed in order to reliably divert flow into the main canal without pumping. This newly excavated (6.1 million cubic yards of soil) channel constructed primarily with native material would provide relatively unimpeded fish passage, although there would be some in-channel grade control structures. The relocated channel would be paired with a new headworks and removable drum screen to prevent entrainment of fish into the canal. The headworks would be supported by tieback levees. The original channel would be filled in.



This option would involve considerable real estate issues and large volumes of excavation. A new control structure at the inlet to the new main channel to provide head and protect against headcutting is needed as are new levees along the alignment to protect against flood damages and sedimentation. Raising the invert in combination with levees which cut off the majority of the floodplain would undoubtedly cause sediment transport and floodplain impacts which would need to be evaluated. A minimum of several stabilized rock sills spanning the width of the new main channel would be necessary to stabilize invert and prevent headcutting. Bank protection rock hard points and revetment would probably be needed at strategic locations along the new main channel to maintain shape and function under variety of flow conditions. A 2009 cost estimate has been developed for this alternative, this option would likely result in costs >\$77 million.

(Performance Attributes)

Fish Performance (FP): Fish performance would be about the same as baseline but fish would not have to traverse the dam and the slope of the channel is about five times flatter than the ramp proposal. It may theoretically improve passage above baseline. (Though there are other uncertainties associated with this option)

Water Delivery Reliability (WDR): Water delivery reliability would not change from baseline.

Engineering Design & Constructability (EDC): There is a high degree of uncertainty with the stability of the channel. There is a possibility depending on the area geology that additional rock rip-rap may be needed to keep this new channel in place. Because of the large footprint of this project there are environmental concerns that may not allow this project to proceed as the “least environmentally damaging alternative” required under the 404(b) (1) guidelines.

Operations & Maintenance (O&M): Should the new channel migrate beyond in-channel grade control structures, the O&M costs could be high.

Cost Effectiveness (CE): The current cost estimate is considerably higher than the baseline cost estimate.

8. Discuss constructability of fish screens (Creative Idea No. 61) -

Several key elements need to be considered for constructability of this project feature. These elements are care of water, formwork, materials and headwall construction.

Care of water involves isolating work in the river to assure there is a safe and controlled environment to construct the headwall. This is possible with a barrier that protects the construction area from the river. The barrier could be sheetpiling, a cofferdam or a ditch to divert water around the construction site. The measure of protection should be the responsibility of the contractor and based on site conditions.

Accurate formwork is critical to providing a headwall that will readily accept the fish screens and supporting components. Accuracy is possible if the proper coordination takes place by the contractor. Headwall shop drawings need to reflect actual manufacture's dimensions of the fish screens and supporting components. Formwork then needs to be constructed according to these shop drawings.

Materials such as rebar and concrete for the headwall, along with steel for the fish screens need to comply with the contract specifications. Compliance is achieved through the contractors' QC program and Corps' QA program.

Headwall construction is another key element for constructability. Successful execution is influenced by weather, concrete placement operations, and curing. The contractor needs to address each of these to achieve specified contract requirements.

(Performance Attributes)

Fish Performance (FP): No significant impact

Water Delivery Reliability (WDR): No significant impact

Engineering Design & Constructibility (EDC): Care of water and quality control are critical issues.

Operations & Maintenance (O&M): Operation and maintenance of the screens may be impacted by flowage events.

Cost Effectiveness (CE): Costs may be impacted by natural events such as weather.

9. Discuss constructability of modified dam (Creative Idea No. 62) -

Several key elements need to be considered for constructability of the modified dam. These elements are care of water, survey, materials and construction execution.

Care of water involves isolating work in the river to assure there is a safe and controlled environment to construct the dam. This is possible with a barrier that protects the construction area from the river. The barrier could be sheet piling, a cofferdam or a ditch to divert water around the construction site. The measure of protection should be the responsibility of the contractor and based on site conditions. To maximize operations, it is likely the barrier will encompass half of the dam construction site along with the ramp area behind this area of the dam. Any restrictions on the work area need to be spelled out in the contract.

An accurate survey is critical to achieving design elevations and coordinates. Any errors carried through construction will likely jeopardize performance attributes of the project. The contractor can address this element by hiring a competent licensed surveyor capable of precise layout of the dam.

Materials such as rebar, concrete, precast units, rock, and soil must comply with the contract specifications. Compliance is achieved through the contractors' QC program and Corps' QA program.

Construction execution is another key element for constructability of the dam. Successful execution is influenced by weather, concrete placement operations, and curing. The contractor needs to address each of these to achieve specified contract requirements.

(Performance Attributes)

Fish Performance (FP): No significant impact

Water Delivery Reliability (WDR): No significant impact

Engineering Design & Constructability (EDC): Care of water and quality control are critical issues.

Operations & Maintenance (O&M): Operation and maintenance of the Dam may be impacted by flowage events.

Cost Effectiveness (CE): Costs may be impacted by natural events such as weather.

10. Discuss constructability of fish ramp (Creative Idea No. 63) -

Several key elements need to be considered for constructability of this project feature. They are care of water, survey, materials and construction execution.

Care of water involves isolating work in the river to assure there is a safe and controlled environment to construct the fish ramp. This is possible with a barrier that protects the construction area from the river. The barrier could be sheetpiling, a cofferdam or a ditch to divert water around the construction site. The measure of protection should be the responsibility of the contractor and based on site conditions. To maximize operations, it is likely the barrier will encompass half of the dam construction site along with the ramp area behind that portion of the dam. Any restrictions on the work area need to be spelled out in the contract.

An accurate survey is critical to achieving design elevations and coordinates. Any errors carried through construction will likely jeopardize performance attributes of the project. The contractor can address this element by hiring a competent licensed surveyor capable of precise layout of the fish ramp.

Materials such as concrete mats, rock, and soil must comply with the contract specifications. Compliance is achieved through the contractors' QC program and Corps' QA program.

Construction execution is another key element for constructability of the fish ramp. Successful execution is influenced by weather, equipment and placement operations. The contractor needs to address each of these to achieve specified contract requirements.

(Performance Attributes)

Fish Performance (FP): No significant impact

Water Delivery Reliability (WDR): No significant impact

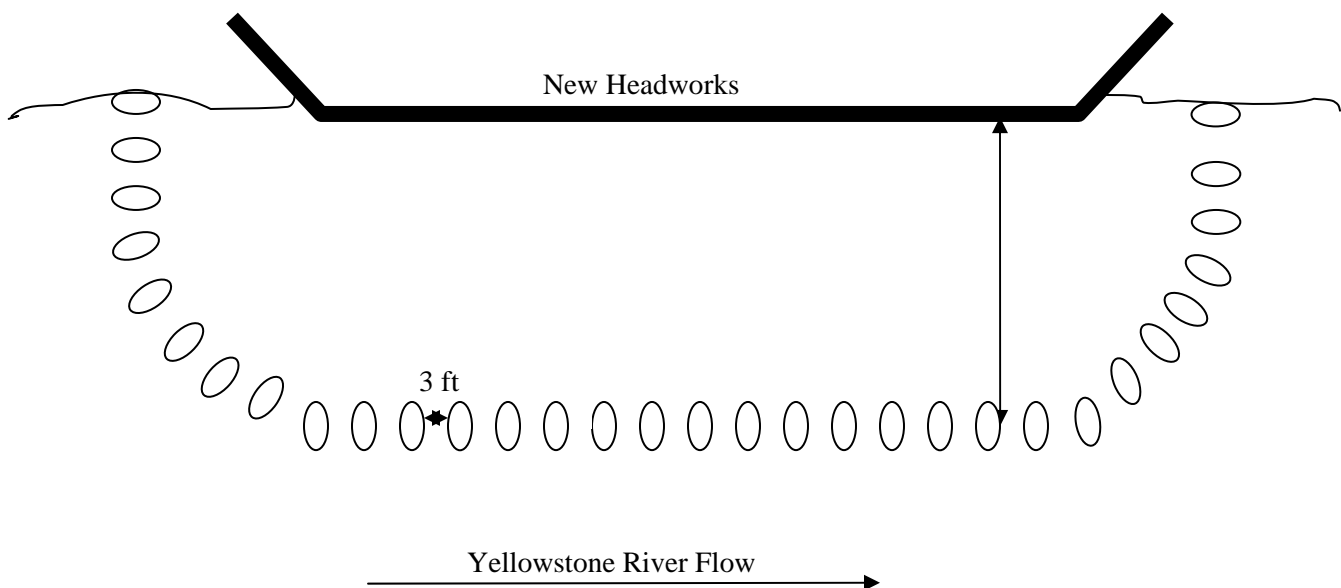
Engineering Design & Constructability (EDC): Care of water and quality control are critical issues.

Operations & Maintenance (O&M): Operation and maintenance of the Fish Ramp may be impacted by flowage events.

Cost Effectiveness (CE): Costs may be impacted by natural events such as weather.

11. Design trash racks for cylindrical screens (Creative Idea No. 71) -

Including a barrier composed of reinforced concrete bollards in front of the fish screen would not impact water flow/delivery to the screens but would protect the screens from debris and may help keep the adult pallid sturgeon away from the screens. The top elevation would need to be set at a level below impact of most ice but high enough to screen debris under most flow conditions. If the bollards are too tall to the point where ice loads stack up on them they would need to be designed much stronger to resist the ice loads. Top elevation would need to be optimized through hydraulic modeling. Bollards could potentially be incorporated into the cofferdam for construction of the new headworks.



(Performance Attributes)

Fish Performance (FP): No significant impact.

Water Delivery Reliability (WDR): No significant impact.

Engineering Design & Constructibility (EDC): additional modeling and design work would be suggested to optimize this suggestion.

Operations & Maintenance (O&M): No significant impact.

Cost Effectiveness (CE): There would be added cost for the additional bollards.

12. Optimize top elevation of headworks (Creative Idea No. 83) -

The top of headworks elevation was arbitrarily set in the preliminary design. While it is necessary to provide structure height to minimize risk of damage to project components during major events, the headworks height is directly related to cost. Therefore, the

optimization of the structure height should be valuable to achieve cost savings. Factors to consider in headworks elevation include extreme flood events due to both open water and ice conditions.

(Performance Attributes)

Fish Performance (FP): No significant impact.

Water Delivery Reliability (WDR): No significant impact.

Engineering Design & Constructability (EDC): No significant impact.

Operations & Maintenance (O&M): O&M costs are reduced since the long-term risk for the headworks reduced.

Cost Effectiveness (CE): Life cycle cost is positive and the risk of extreme event flood damage is limited.

13. Build Dam Out of RCC (Creative Idea No. 84) -

Roller compacted concrete (RCC) has been used for decades to successfully build dams (both large and small) and slope supporting berms to name just two applications. The use of RCC in this application would allow building the dam and ramp at the same time (with final rock surface on ramp).

The baseline dam (reinforced concrete) would be replaced with the roller compacted concrete. It is a rapid construction technique and instantly stable. The dam and ramp could be built at the same time (with final rock surface on ramp). The layering placement would allow for differing crest elevations designed in after physical modeling. RCC construction is a rapid construction technique and instantly stable. It may allow construction in one season; minimal forming, pumping of concrete, and weather placement issues are minimized.

There are some drawbacks or concerns with the RCC. A specialty contractor would be required. Adequate mix design and quality control oversight are important to alleviate problems with performance during the design life. The staging of stockpiled materials will need to be performed in advance, but the amount is small since the total crest amount needed is approximately 4100 cubic yards. It is not preferred to be constructed in cold weather conditions. This will need a leveling base pad to start the layering. May or may not end up with stepped upstream face, but the side slopes can be sacrificial during placement and excess graded smooth and compacted. It is not preferred to be constructed in cold weather conditions.

(Performance Attributes)

Fish Performance (FP): There should be no effect to the fish passage due to the small effective surface as compared to the ramp length.

Water Delivery Reliability (WDR): Water delivery is actually enhanced somewhat because the existing dam may be pervious.

Engineering Design & Constructability (EDC): The E&D would be simpler than designing a hardened concrete structure. Will not have to deal with pumping of concrete and forming as with the current design.

Operations & Maintenance (O&M): The operation is a non-issue with no moving parts; the maintenance should be minimal as long as the original mix and placement are done correctly and adequately.

Cost Effectiveness (CE): The cost for any size project is typically in the \$40 to \$80 per cubic yard range. The cost is essentially offset by the ease of placement and shorter construction time (as compared to reinforced concrete).

14. Incorporate a spillway to minimize velocities on the ramp during high flow, vary ramp width (Creative Idea No. 85, 97) -

A spillway could be constructed off the right bank within the floodplain area adjacent to the ramp, commonly known as Joe's Island. The land is already Bureau of Reclamation owned. A bench would be excavated within the island area to reduce ramp flow velocity and decrease erosion pressure on the ramp. A modified version of this would be to provide selected widened areas to vary the ramp width. This would alter the amount of the ramp passing the depth and velocity fish performance criteria. This may be preferable to also provide low flow velocity fish passage resting areas along the bank.

Negatives with adding a spillway to the ramp include tree loss and the requirement to mitigate for the excavated area. In addition, the excavated material would add cost for material disposal. Detailed hydraulic modeling is required to evaluate a minimum bench width to be effective. If extreme event modeling determines concerns with ramp stability, then a floodplain bench should be investigated further.

The possibility to vary the ramp width should be investigated further with hydraulic modeling efforts. The varying width, if properly designed, may enhance fish passage performance.

(Performance Attributes)

Fish Performance (FP): Varying the ramp width will provide flow relief for higher flows and increase fish performance.

Water Delivery Reliability (WDR): No significant impact.

Engineering Design & Constructability (EDC): Additional effort is required for design and constructability although it should be minor.

Operations & Maintenance (O&M): No significant impact.

Cost Effectiveness (CE): Cost impact is likely to be minor.

15. Ensure that the low flow channel within the ramp ties in with the natural thalweg at the toe of the ramp (Creative Idea No. 96) -

The pallid sturgeon are presumed to use the thalweg and vicinity for upstream migration. Therefore, establishment of a continuous thalweg through the ramp that connects with the existing thalweg downstream of the ramp would likely benefit sturgeon migration. The design of the low flow channel will need to evaluate impact on flow velocity and the possibility of erosion in the thalweg vicinity. It is also preferred that the top of the ramp

low flow channel exit away from the fish screen even though this is the location of the thalweg behind the dam.

(Performance Attributes)

Fish Performance (FP): Providing a low flow channel will improve fish migration and increase ramp fish performance.

Water Delivery Reliability (WDR): No significant impact.

Engineering Design & Constructability (EDC): Additional effort is required for design and constructability although it should be minor.

Operations & Maintenance (O&M): No significant impact.

Cost Effectiveness (CE): Cost impact is likely to be minor.

16. Consider energy dissipaters at ramp toe to help control velocities (Creative Idea No. 98) -

The ramp toe is expected to be an area of concern for stability. Observations of ramps in the field have shown erosion of downstream channel bed and bank material. Including an energy dissipation feature at the ramp toe will reduce the erosion potential. A traditional stilling basin with an end sill is not preferred for this location. An end sill is likely to negatively impact fish passage. Either providing a rock lined transition flat bed or a preformed scour hole is probably the most feasible. While likely a minor depth, a preformed scour hole does require material removal within the river bed. Properly designed and constructed, the impact on fish performance is not significant. Potential savings on future O&M costs associated with bed and bank erosion could be significant.

(Performance Attributes)

Fish Performance (FP): No significant impact.

Water Delivery Reliability (WDR): No significant impact.

Engineering Design & Constructability (EDC): Additional effort is required for design and constructability although it should be minor.

Operations & Maintenance (O&M): The energy dissipation function will significantly reduce O&M at the ramp toe and downstream.

Cost Effectiveness (CE): Cost impact will occur to build the energy dissipation feature.

17. Stockpile extra rock for future maintenance (Creative Idea No. 116) -

The suggestion would stockpile rock (or whatever material is chosen for the ramp) on-site (or within a reasonable distance) to use post-construction. The justification for expending project funds for this extra material is the realization that emergency repairs may be impeded if an adequate supply of material is not readily available or attainable.

In terms of potential locations, the Corps could stockpile next to the quarry currently used as a rock source by the Irrigation District (figure 1, option 1); could also use the temporary stockpile location (figure 1, option 2) as a long-term stockpile. Another option

would be to stockpile in the canal behind the existing headworks (figure 1, option 3) if a new headworks is built upstream.



Stockpiling would allow the Corps to have material on-site if adaptive management was needed. It would also allow for the Irrigation District to utilize pre-purchased rock for O&M.

Advantages

- Allows maintenance when needed without delays to obtain material
- Supports adaptive management
- Could be acquired with project construction funds and save the Irrigation District on O&M costs in the future
- Would ensure that appropriate quality rock is being used for future maintenance
- Could save on schedule if more rock than was estimated is needed for the project

Disadvantages

- Volume of stockpile could be significant
- Security measures would be needed to ensure rock isn't stolen
- Would not be aesthetically pleasing if piled near the River and fishing access site
- Could pose a public safety hazard
- Would increase construction costs

(Performance Attributes)

Fish Performance (FP): No significant impact.

Water Delivery Reliability (WDR): No significant impact.

Engineering Design & Constructibility (EDC): No significant impact.

Operations & Maintenance (O&M): Would decrease O&M costs since rock would not need to be acquired for O&M for the first several years after construction. Could use stockpiled rock to replace any rock displaced by ice or other forces. Can better address emergency needs.

Cost Effectiveness (CE): Would increase the costs of construction because more rock than is necessary for actual construction would need to be acquired.

18. Use design/build for screens (Creative Idea No. 119) -

Construction of the concrete headworks structure and fish screens will be accomplished using the Initiation for Bids (IFB) contracting method wherein the contract documents include a complete design and specify the screen type, materials, overall size, mesh opening size, and cleaning method. Minor details of the screen interface with the concrete headworks may vary between different manufacturers, and therefore would be designed by the contractor and submitted for approval. This comment idea is to instead use the Design/Build contracting method for the fish screens. Presumably the complete design of the concrete headworks structure would still be completed and contracted IFB, but the contract specs would give performance requirements for the fish screens and would require the contractor to completely design all aspects of the screen system.

Although design/build is not the normal procedure for procuring fish screens, it would allow greater flexibility of screen selection and may allow a manufacturer to use their proprietary technology.

(Performance Attributes)

Fish Performance (FP): There are not be expected to be any differences in performance relative to screening fish because use of either contracting method must provide screens that meet the NOAA requirements.

Water Delivery Reliability (WDR): Diversion of unscreened water will not be permitted after the ramp construction is complete (although an exception to allow a single unscreened opening for a short time during screen maintenance is a possibility that is being investigated). Therefore reliability of the screens is vital. There may be differences in reliability of between different screen types, but this is unknown at this time.

Engineering Design & Constructability (EDC): Design/build would have the advantages of shortening the design schedule, and also of placing responsibility for the screens functioning properly entirely on the contractor.

Operations & Maintenance (O&M): There is no apparent difference in O&M cost.

Cost Effectiveness (CE): Design/build would reduce design cost, but there would increase construction cost.

19. Use multiple fabricators to build screens (Creative Idea No. 120) -

This variation would likely have a significant impact on initial installation due to possible dimensional differences and O&M resulting from screens that are not interchangeable. This idea should only be considered if schedule becomes a critical issue. If multiple fabricators are used, Quality Control will be a priority.

(Performance Attributes)

Fish Performance (FP): No significant impact.

Water Delivery Reliability (WDR): No significant impact.

Engineering Design & Constructibility (EDC): This could potentially reduce schedule time.

Operations & Maintenance (O&M): Could be an issue with the potential of non-interchangeable parts.

Cost Effectiveness (CE): No significant impact.

20. Purchase Order screens and rock and inspect as government-supplied materials (Creative Idea No. 121) -

This is definitely a tool to help meet schedule. Funds can be obligated by the end of fiscal year even though a major contract (three months plus) has not been awarded to start the normal procurement process. It may work well with design/bid/build approach also. The process could be used to stockpile rock incase it is not available in future.

Could increase contractor claims if supplied products do not meet the prime contractors portion of the work (i.e. design changes). Will need to know rock sizing due to ice forces early in procurement process, and also the screen design early.

(Performance Attributes)

Fish Performance (FP): No significant impact.

Water Delivery Reliability (WDR): No significant impact.

Engineering Design & Constructibility (EDC): No significant impact.

Operations & Maintenance (O&M): No significant impact.

Cost Effectiveness (CE): This may relate to reduced cost for these materials but if the contractor may have issues with the materials and could claim for the conflicts.

21. Use submerged curtain downstream to keep fish out of construction zone (Creative Idea No. 123) -

This concept addresses the concern that adult and juvenile pallid sturgeon may wander into the construction zone and experience injury or mortality. It is suggested that a temporary curtain be installed downstream of the construction area in order to discourage pallid sturgeon from reaching the area of danger. Once construction is complete, the curtain may be removed to allow free movement of fish.

(Performance Attributes)

Fish Performance (FP): This proposal is about the same as baseline but would help protect adult fish by keeping them out of the construction zone. This would be essential

if construction occurs in the wet but also may allow extending work into the migration season.

Water Delivery Reliability (WDR): Water delivery reliability would not change from baseline.

Engineering Design & Constructability (EDC): This may allow more flexibility in construction by allowing work to occur in the wet or possibly during the fish migration season. This proposal could be considered as an added construction component. However, it may be possible to use a silt curtain which may be required by water quality regulations.

Operations & Maintenance (O&M): The O&M would be about the same.

Cost Effectiveness (CE): The cost effectiveness is about the same.

22. Explore use of rock from Montana Rail Link tunnel project west of Helena; and Montana DOT (Creative Idea No. 129) -

Montana Rail Link (MRL) is in the process of constructing a tunnel widening and shortening project at their Mullan Tunnel. Phone conversations with Richard Keller, Chief Engineer, indicated that a total of approximately 100,000 cubic yards of material is anticipated to be removed during the tunnel project. Mr. Keller indicated most of this is a product of shortening the tunnel and would include some overburden. The rock blasting is underway and is scheduled for completion by the end of August 2009. MRL is currently stockpiling the rock at the west side of the tunnel. Mr. Keller estimated that the rock is generally 2 to 4 feet in size and that they may be interested in getting rid of some rock. Recommend continued coordination with the railroad and potential site visit to their stockpile as project progresses as a potential source of rock.

In addition, communications should be opened with the Department of Transportation regarding the availability of rock and stone from some of their projects.

(Performance Attributes)

Fish Performance (FP): No significant impact.

Water Delivery Reliability (WDR): No significant impact.

Engineering Design & Constructability (EDC): No significant impact.

Operations & Maintenance (O&M): No significant impact.

Cost Effectiveness (CE): A more local source of suitable rock may provide a significant cost reduction to the project.

VALUE ENGINEERING PROCESS

GENERAL

This report section describes the procedures used during the Value Engineering Study. It is followed by the VE Study Agenda

A systematic approach was used in the VE study and the key procedures followed were organized into three distinct parts: (1) pre-study preparation, (2) VE study, and (3) post-study procedures.

PRE-STUDY PREPARATION

In preparation for the VE study, the facilitator (CVS) and VE team members reviewed the project documents provided by the Project Development Team to become better prepared for the study. The project documents consisted, in part, of:

- *2007 Annual Report, Biological Opinion on the Operation of the Missouri River Main Stem System, Operation and Maintenance of the Missouri River Bank Stabilization and Navigation Project, and Operation of the Kansas River Reservoir System, Prepared by: U.S. Army Corps of Engineers, Omaha and Kansas City Districts, April 9, 2008.*
- *“Water Resources Development Act of 2007”, Public Law 110–114, November 8, 2007.*
- *Lower Yellowstone Dam Feature History, May 4, 1910 to May 1, 1912, Department of the Interior, United States Reclamation Service.*
- *Lower Yellowstone River, Intake Dam Fish Passage. Alternatives Analysis, U.S Army Corps of Engineers, Omaha District, June, 2002*
- *Value Engineering Study Report Intake Diversion Dam Fish Protection and Passage – Lower Yellowstone Project, Conducted in Cooperation with the Lower Yellowstone Irrigation Project Board of Control, Fisheries Department University of Idaho, United States Fish and Wildlife Service, Bureau of Reclamation Great Plains Region and Montana Area Office, July 29, 2002.*
- *Lower Yellowstone – Intake Diversion Dam, ESA Modifications Alternative Evaluation Matrix, Explanatory Document, November 2005*
- *Lower Yellowstone River Fish Passage, Alternatives Value Planning Study, Conducted in Cooperation with the State of Montana Fish Wildlife & Parks, Lower Yellowstone Irrigation Districts, U.S. Army Corps of Engineers, United States Fish and Wildlife Service, the Bureau of*

Reclamation Technical Service Center, and the Bureau of Reclamation Great Plains Region and Montana Area Office, August 10, 2005.

- *Intake Diversion Dam, Yellowstone River, Montana, Fish Protection and Passage Concept Study Report, Water Resources Research Laboratory, Bureau of Reclamation, Denver, Colorado, January 2000.*
- *Assessment of Behavior and Swimming Ability of Yellowstone River Sturgeon, for Design of Fish Passage Devices, by Robert G.White, Ph.D., Montana Cooperative Fishery Research Unit, Montana State University-Bozeman, Bozeman, Montana and Brent Mefford, P.E., Water Resources Research Laboratory, Bureau of Reclamation, Denver, Colorado, January 10, 2002.*
- *Water Resources Technical Publication, Fish Protection at Water Diversions, A Guide for Planning and Designing Fish Exclusion Facilities, U.S. Department of the Interior Bureau of Reclamation, Denver, Colorado, April 2006.*
- *Juvenile Fish Screen Criteria, Developed by National Marine Fisheries Service Environmental & Technical Services Division Portland, Oregon Revised February 16, 1995.*
- *Power to Detect Trends in Pallid and Shovelnose Sturgeon Populations in the Missouri River, Prepared by: M. Zachariah Peery, Sustainable Ecosystems Institute, Portland, Oregon, December 2004.*
- *Independent Science Review of the Pallid Sturgeon Assessment Program: Final Report, Sustainable Ecosystems Institute, Portland, Oregon.*
- *Review of the Recovery Program for the Endangered Pallid Sturgeon in the Upper Missouri River Basin, A Report Prepared by the Western Division of the American Fisheries Society for the Upper Basin Pallid Sturgeon Workgroup, July 2004.*
- *10% Design Analysis for the Intake Diversion Dam, Project Management Plan, U.S. Army Corps of Engineers, Omaha District, March 1, 2006.*
- *DRAFT Hydraulic Laboratory Report HL-2007-010, Intake Diversion Dam Fish Screens, Evaluation of Fish Screens for Protecting Early Life Stages of Pallid Sturgeon, U.S. Department of the Interior, Bureau of Reclamation Technical Service Center, Water Resources Research Laboratory Denver, Colorado, November 2007.*
- *Lower Yellowstone Project, Preliminary Concept Alternatives for the EIS, November 10, 2008.*
- *Lower Yellowstone River Intake Dam Fish Passage and Screening Preliminary Design Report, U.S. Army Corps of Engineers, Omaha District, July 2006.*
- *Lower Yellowstone River Intake Dam Fish Passage and Screening Final Design Report, U.S. Army Corps of Engineers, Omaha District, July 2006.*
- *Appendix I, Additional Ramp Alternative, Final Report, Lower Yellowstone Project Fish Passage and Screening, Preliminary Design Report. Intake Diversion Dam, February 2007.*

- *Lower Yellowstone Project Fish Screening and Sediment Sluicing Preliminary Design Report, U.S. Army Corps of Engineers, Omaha District, February 2008.*
- *Intake Diversion Dam, Trashrack Appraisal Study for Intake Headworks, Lower Yellowstone Project – Montana – North Dakota, U.S. Department of the Interior, Bureau of Reclamation, February 2008.*
- *Various Miscellaneous Reports, Articles, Fact Sheets, Maps, Photographs, Cost Estimates and Presentations.*

These documents were provided by the Omaha District of the USACE and the U.S. Bureau of Reclamation.

VE STUDY

This value engineering workshop was a five-day study effort. The SAVE International Value Engineering job plan was followed, where applicable, to guide the team in developing alternative solutions and recommendations for consideration in resolving and managing the issues and problems associated with fish protection and passage across the Lower Yellowstone River Irrigation Dam.

The standard, five job plan phases are:

- ♦ Information Phase (including Function Analysis)
- ♦ Creative Phase
- ♦ Evaluation Phase
- ♦ Development Phase
- ♦ Presentation Phase

Information Phase

At the beginning of the VE study, discussions by the project manager for the USACE in Omaha presented a more detailed review of the issues associated with the creation of fish passage system across the Lower Yellowstone River Irrigation Dam while maintaining the required water supply to the local irrigation districts, examining current plans and programs to seek out alternative approaches and ideas that will improve the overall performance of the program. The presentation, and opportunity to obtain responses to questions, further enhanced the VE team's knowledge and understanding of the issues. The discussion clarified many questions of the VE team allowing the team to focus on developing alternatives for addressing and managing the issues and problems associated with the Lower Yellowstone River Irrigation Dam, Fish Protection and Passage Project.

During this phase, the VE team further defined the project goals, key criteria, critical issues and project constraints during the information phase of the study (see **Appendix A**). This phase culminated in the team defining project functions and developing a Function Analysis System Technique (FAST) diagram (see **Appendix C**).

Creative Phase

This VE study phase involved identifying and listing creative ideas. During this phase, the VE team participated in a brainstorming session to identify as many means as possible to provide the necessary functions within the project. Judgment of the ideas was not permitted at this point. The VE team looked for a large quantity of ideas and association of ideas. The project functions developed by the VE team are listed in **Appendix C**.

The creative idea worksheets listing all ideas suggested during the study are provided in this report (see **Appendix D**). This list should be reviewed, since it may contain ideas that are worthy of further evaluation, and may be used as the problem solutions develop. These ideas could also help stimulate additional ideas by others.

Evaluation Phase

The purpose of the evaluation phase was to systematically reduce/combine the large number of ideas generated during the creative phase to a number of concepts/alternatives that appear promising in meeting the project objectives. The key performance criteria against which the ideas need to be evaluated were identified as Fish Performance; Water Delivery Reliability; Engineering Design & Construction; Operations & Maintenance and Cost Effectiveness. Once each idea was fully evaluated, it was rated.

Based upon the rating, ideas rated positively where the VE team could assess significant impacts were developed further into Value Engineering Alternatives, and documented in the Value Engineering Alternatives section of this report. Additional ideas were developed into design suggestions or other considerations as they were deemed important in value to the overall success of the project. The balance of the ideas that were found to add no value to resolving the issues were dropped from further consideration.

Development Phase

During the development phase, each idea was expanded into a workable solution. The development consisted of the recommended alternatives and a brief narrative describing the justification for the proposed alternatives. A cost estimate for this project was made available to the VE team. The alternatives are included in the VE Alternatives section of this report.

Presentation Phase

The VE study concluded with a preliminary presentation of the VE alternatives that have been developed, along with a list of those ideas or combination of ideas that the VE team believed offered the most value to the stakeholders. This provides others impacted by the results of the study with an opportunity to preview the alternatives and develop an understanding of the rationale behind them.

VE STUDY WORKSHOP AGENDA



Lower Yellowstone River Irrigation Diversion Dam, Fish Protection and Passage U.S. Army Corps of Engineers Omaha District Value Engineering Study Agenda

Monday, June 1, 2009

- 8:30 Introductions
- 8:45 Brief Overview of the VE Process (Ron Tanenbaum)
- 9:15 Project History – Background – Constraint (USACE & BUREC Representatives)
- 9:45 Design Overview (Design Team)
- 10:30 Break
- 10:45 Designer Presentation (Cont.); Critical Issues, Project Constraints (All)
- 11:30 *Lunch Break*
- 12:30 Cost Estimate and Cost Model
- 1:30 VE Objectives/ Focus/ Opportunities/ Performance Attributes (Ron Tanenbaum)
- 3:30 Function Analysis and FAST Diagram

Tuesday, June 2, 2009

- 8:30 Review of Previous Day's Findings
- 9:00 Creative Phase/Idea Generation
- 10:15 Break
- 10:30 Creative Phase/Idea Generation (Continued)
- 11:30 *Lunch Break*
- 12:30 Team Evaluation of VE Alternatives
- 3:00 Break
- 3:15 Team Evaluation of VE Alternatives (Continued)

Wednesday, June 3, 2009

- 8:30 Team Evaluation of VE Alternatives (Continued)
- 10:00 Break
- 10:15 Development of VE Alternatives (Items are assigned to the team member to document recommended alternatives and impacts of those alternatives)
- 11:30 *Lunch Break*
- 12:30 Development of VE Alternatives (Continues)



**Lower Yellowstone River Irrigation Diversion Dam,
Fish Protection and Passage
U.S. Army Corps of Engineers Omaha District
Value Engineering Study Agenda**

Thursday, June 4, 2009

8:00 Development of VE Alternatives (Continues)
11:30 *Lunch Break*
12:30 Development of VE Alternatives (Continues)

Friday, June 5, 2009

8:00 Team Review of VE Alternatives; Prepare for Presentation
10:30 ***Management Outbriefing Presentation***
12:00 *Workshop Close-out*

PROJECT DESCRIPTION, PROJECT CRITICAL ISSUES, CONSTRAINTS, AND PERFORMANCE ATTRIBUTES

PROJECT DESCRIPTION

Introduction

The U. S. Fish and Wildlife Service (Service) listed the pallid sturgeon (*Scaphirhynchus albus*) as endangered under the Endangered Species Act (ESA) in 1990. The Lower Yellowstone River is part of the historic habitat range for pallid sturgeon and many other native warm water fish species (e.g. paddlefish, blue sucker, burbot, etc...). The lower Yellowstone River has been identified by the Service as one of the best opportunities for recovery of pallid sturgeon, because sturgeon are still in the area, and there is suitable habitat in the river for restoration and recovery.

Construction of the Lower Yellowstone Project began in 1905 and included Intake Diversion Dam - a 12-foot high wood and stone structure that spans the Yellowstone River and raises the water level for the diversion. Intake Diversion Dam likely has impeded upstream migration of pallid sturgeon and other native fish for more than 100 years. The best available science suggests that the diversion dam is a partial barrier to some species and is likely a total barrier to other species, such as pallid sturgeon, due to impassable turbulence and velocities associated with the rocks at the dam and downstream. In addition, entrainment studies in the late 1990's indicated that the diversion structure traps numerous fish in the canal system due to the lack of any screens on the gates.

Regulatory environmental agencies (U.S. Fish and Wildlife Service and State of Montana Department of Fish, Wildlife and Parks) have been actively pursuing resolution of the fish passage and entrainment issues with the Bureau of Reclamation. Resolution of these issues would minimize entrainment in the canal and provide open access for migration to another 165 river miles of habitat including the confluences of two major tributaries (Powder River and Tongue River).

The study area is located along the Lower Yellowstone River in the vicinity of the Intake Diversion Dam, approximately 18 miles downstream from the City of Glendive, Montana. The project site includes the dam and diversion structure, the upper 3,000 feet of the Lower Yellowstone Project Main Canal, and extends from about 3 miles downstream of the Dam to about 5 miles upstream from the dam

The general study area is shown in **Figure 1**. **Figure 2** shows the study area from a 2005 aerial photograph.

VALUE ENGINEERING TEAM STUDY

APPENDIX A: PROJECT DESCRIPTION, PROJECT CRITICAL ISSUES,
CONSTRAINTS, AND PERFORMANCE ATTRIBUTES

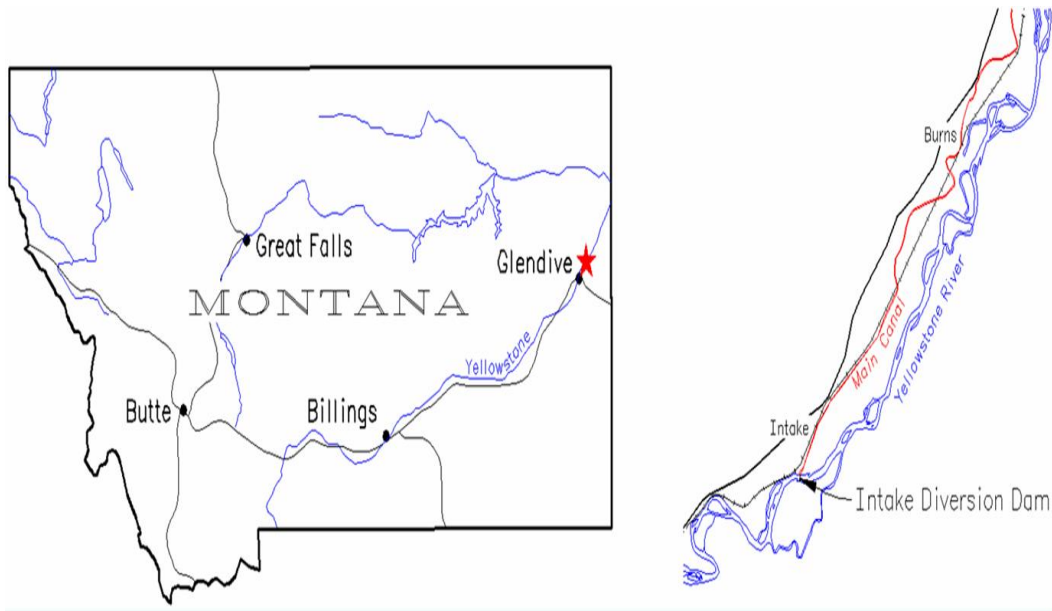


Figure 1 - Project Map for Lower Yellowstone River Irrigation Dam, Fish Protection and Passage Project



Figure 2 – Project Site Map (2005 Aerial Photograph)
VALUE ENGINEERING TEAM STUDY

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APPENDIX A: PROJECT DESCRIPTION, PROJECT CRITICAL ISSUES, CONSTRAINTS, AND PERFORMANCE ATTRIBUTES

The Intake Dam is the diversion dam for the Lower Yellowstone Project is an irrigation project covering about 55,000 acres in far eastern Montana and western North Dakota. The Intake Dam itself is a timber and rock-filled weir (dam) owned by the Bureau of Reclamation that was originally constructed from 1905-08. The dam is approximately 12 feet high and spans across the entire width of the Yellowstone River, about 650 feet. The purpose of the dam is to create sufficient head to allow diversion of water into the main canal for distribution throughout the rest of the project. Due to extreme flood flows and ice damages, the original dam has required fairly intensive upkeep in the form of placing rock on the dam crest to maintain the grade. Over the years the rock has been pushed downstream to form rock rapids that extend about 200-300 feet below the dam.

Alternatives Under Consideration

Currently there are six alternatives being considered for this project; four relating to fish passage options and two relating to screen types. The following information is taken from *Lower Yellowstone Project Preliminary Concept Alternatives for the EIS* provided by the USACE Omaha District, and is included herein for reference. Provided at the end of each alternative are sketches and pictures illustrating each idea that were obtained from various presentations prepared by the Corps.

1. Relocate Diversion Upstream.

The idea behind this concept is to use the natural slope of the river and associated water surface elevations to provide the head for the diversion flows without the need for a diversion dam. The existing dam would be removed and the canal inlet relocated upstream to a location where the natural water surface of the river would be sufficient to divert the required flow (1,400 cfs). A new 2-mile section of canal would be constructed with two crossings beneath the existing Yellowstone Valley Railroad. Because the diversion capacity must be met under low flow conditions (5,000 cfs) and there will not be a dam to ensure the head, efficiency will be reduced resulting in the need for more diversion pipes and screens than at the existing headworks. Also, in order to ensure diversion under low flow conditions, significant channel engineering would be required to maintain the channel invert adjacent to the diversion headworks. Finally, to protect the new canal from flooding and associated sedimentation, levees would be constructed along the floodplain.

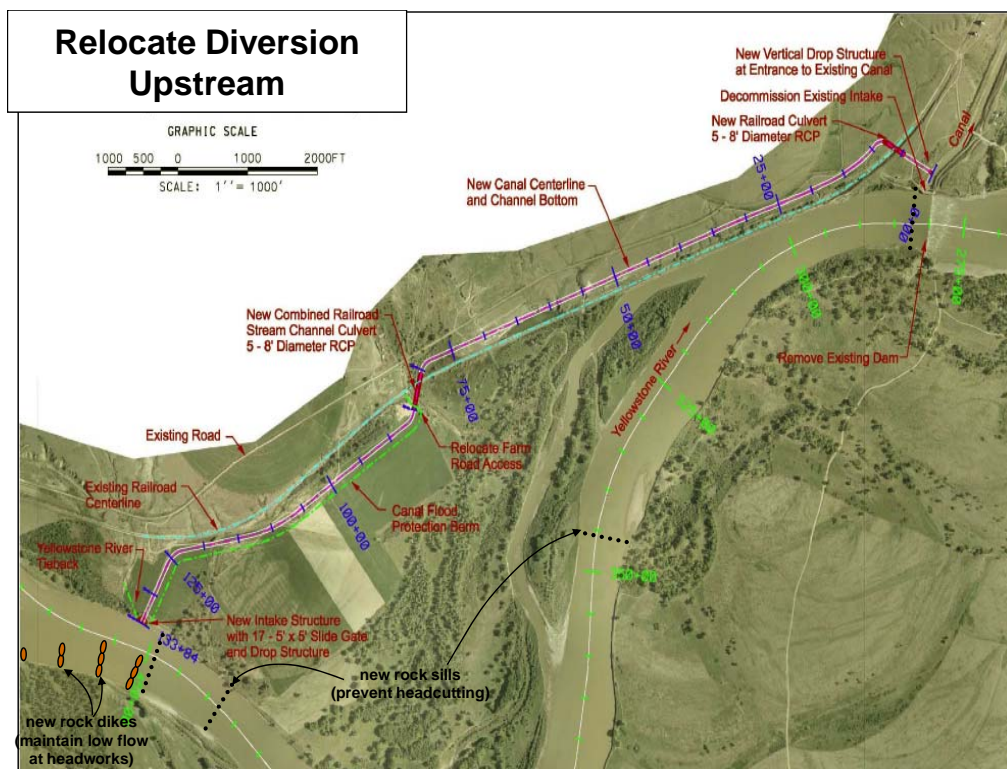
VALUE ENGINEERING TEAM STUDY

APPENDIX A: PROJECT DESCRIPTION, PROJECT CRITICAL ISSUES, CONSTRAINTS, AND PERFORMANCE ATTRIBUTES

- New inlet approximately 2-miles upstream from existing dam;
- Construct new headworks with 17 (seventeen) 5-foot diameter gated pipes (versus 11 on the existing headworks);
- Either screen would work, but the removable screens would be preferable due to need to construct a new headworks facility;
- Excavate 2-miles of new canal, the majority of which is a deep cut (60-ft deep) through a steep hillside;
- Due to the depth of excavation required the estimated volume of cut required is approximately 3.7 million cubic yards;
- New canal alignment runs parallel to the Yellowstone Valley Railroad and crosses under the track at two locations through construction of inverted siphons consisting of 5 (five), 8-foot diameter concrete pipes per siphon;
- New drop structure at location where new canal joins the existing canal.
- Upstream section of the canal includes construction of levees along the alignment to protect against flood damages and sedimentation;
- A minimum of several stabilized rock sills spanning the width of the Yellowstone River main channel would be necessary to prevent headcutting of the main channel once the dam is removed;
- River training dikes and revetment would be constructed in the vicinity of the new headworks and upstream to fix the invert of the channel adjacent to the headworks for flow diversion purposes; and
- The rough cost estimate for construction of the new canal, the headworks, the levees, the channel training structures, and removal of the existing dam is approximately \$43 million (2006 price level), not including the cost of the screens.

VALUE ENGINEERING TEAM STUDY

APPENDIX A: PROJECT DESCRIPTION, PROJECT CRITICAL ISSUES, CONSTRAINTS, AND PERFORMANCE ATTRIBUTES



2. Relocate Main Channel.

The idea behind this concept is to open up the existing high flow side channel to serve as the main channel of the Yellowstone and use the existing main channel as the inlet channel to the canal. The majority of the existing main channel would be filled in and would not convey any flows other than those necessary to provide water to the canal. The thought is that by providing a new main channel the need for a diversion dam is avoided and the maximum opportunity for fish passage is provided. The new main channel would be excavated to approximately the same geometry as the existing main channel; however, since no diversion dam is in place to raise the water surface, the invert of the new channel would need to be higher in order to provide the necessary head for the diversion. The new main channel could diverge from the existing main channel at virtually any location and would likely converge near the location of the confluence of the existing high flow channel. A new headworks and control structure would be constructed at the location where

VALUE ENGINEERING TEAM STUDY

APPENDIX A: PROJECT DESCRIPTION, PROJECT CRITICAL ISSUES, CONSTRAINTS, AND PERFORMANCE ATTRIBUTES

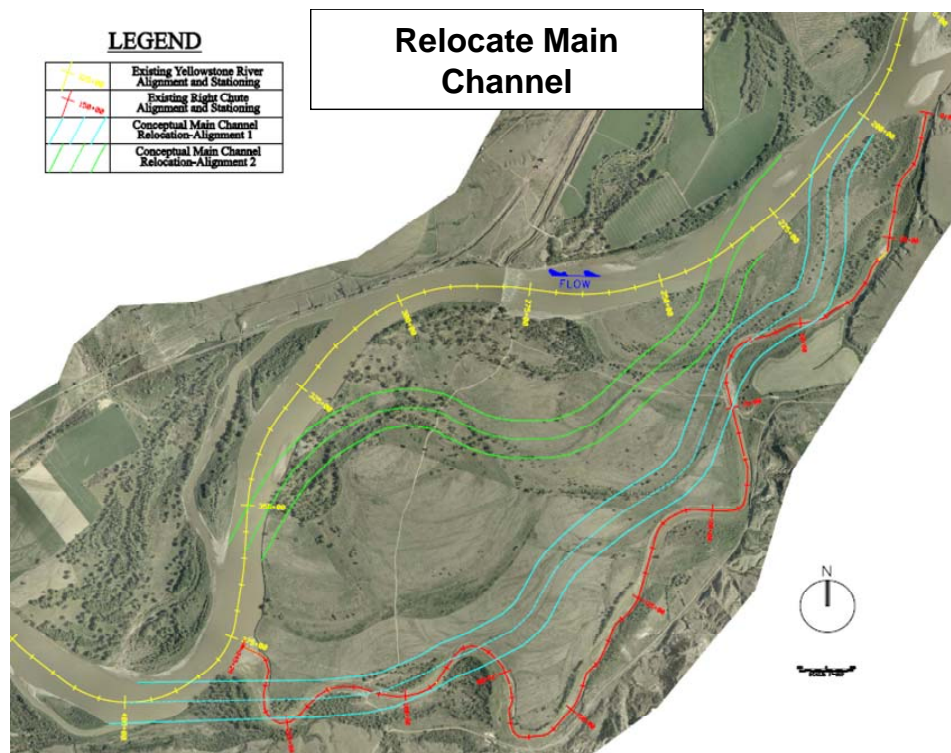
the new main channel diverges from the existing one and the headworks would incorporate a screening facility to provide entrainment protection. The inlet to the new side channel would be engineered to provide sufficient head for diversion under low flow conditions as well as protection against headcutting. As with the Relocate Diversion Upstream Alternative, the new inlet channel would require levees along the floodplain to protect against flood damages and sedimentation. The new main channel would have several stabilized rock sills across its full width to provide additional headcutting protection, and would likely have several other rock points and revetments to maintain shape, location, and function under a variety of flow conditions.

- Excavate a 600-ft wide main channel approximately 3-4 miles in length along the existing high flow channel;
- Due to the depth and length of the excavation required for the new main channel the estimated quantity is from 5 to 8 million cubic yards;
- Fill in entire existing main channel from existing dam downstream to the confluence with the new main channel;
- Fill in majority of the existing main channel from the new headworks downstream to the existing dam leaving just enough channel to convey the canal flows;
- Construct a new headworks assumed to be the same size as the one for the Relocate Diversion Upstream Alternative (17, 5-foot diameter inlet pipes);
- New control structure at the inlet to the new main channel to provide head and protect against headcutting;
- New levees along the alignment to protect against flood damages and sedimentation;
- Raising the invert in combination with levees which cut off the majority of the floodplain would undoubtedly cause sediment transport and floodplain impacts which would need to be evaluated;
- A minimum of several stabilized rock sills spanning the width of the new main channel would be necessary to stabilize invert and prevent headcutting;

VALUE ENGINEERING TEAM STUDY

APPENDIX A: PROJECT DESCRIPTION, PROJECT CRITICAL ISSUES, CONSTRAINTS, AND PERFORMANCE ATTRIBUTES

- Bank protection rock hard points and revetment would probably be needed at strategic locations along the new main channel to maintain shape and function under variety of flow conditions; and
- A 2009 cost estimate has been developed for this alternative, this option would likely result in costs >\$77 million.



3. Rock Ramp.

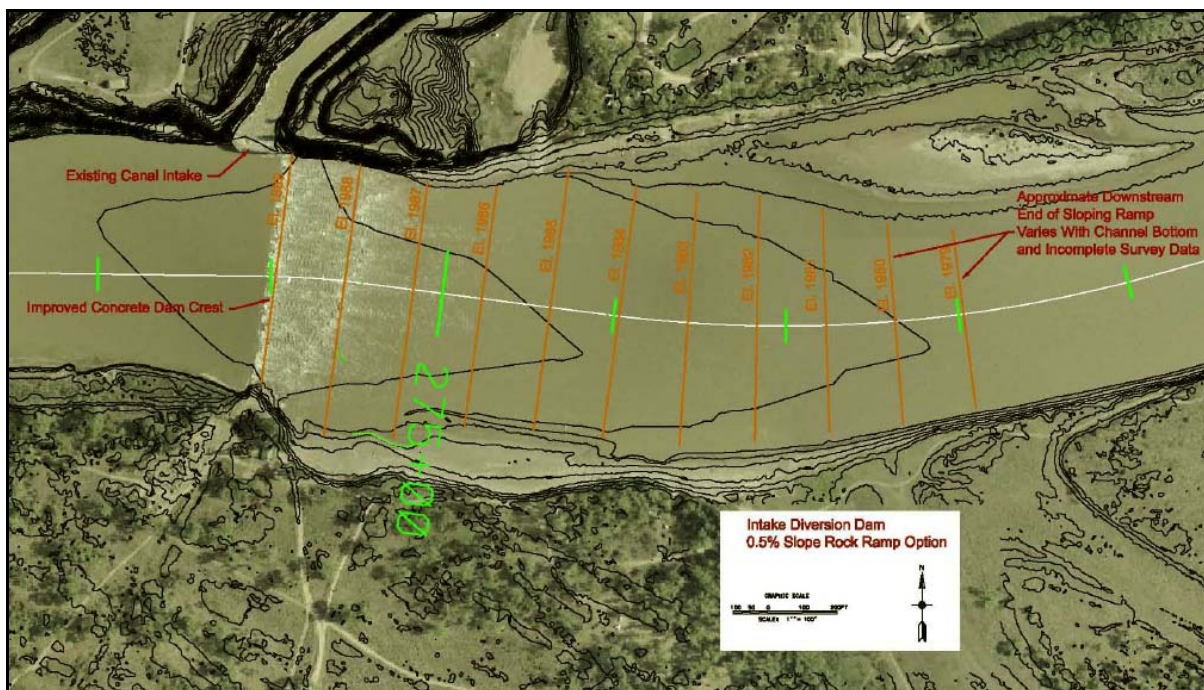
The idea behind this concept is to place fill and rock on the downstream face of the existing dam to flatten out the slope thus reducing velocities and turbulence to tolerable levels allowing for fish passage. The general concept is to attempt to mimic the performance and habitat characteristics of existing natural riffles which are known to be successfully navigated by the target species. Rock ramps are becoming a more common fish passage structure for relatively low dams. The final design of the rock ramp would take into consideration geometry and performance data collected from existing riffles in the Yellowstone and Upper Missouri Rivers. The concept incorporated replacement of the existing timber and rock dam with a reinforced concrete

VALUE ENGINEERING TEAM STUDY

APPENDIX A: PROJECT DESCRIPTION, PROJECT CRITICAL ISSUES, CONSTRAINTS, AND PERFORMANCE ATTRIBUTES

weir to provide improved structure integrity and reduce through seepage. Two alternative ramp designs have been preliminarily evaluated, a stepped ramp with concentric boulder weirs at each step or a smooth rock ramp eliminating the steps and boulder weirs. The smooth ramp has met with greater acceptability among the fish biologists. Weir crest and downstream slopes would vary once the design is finalized to provide a high degree of confidence that the ramp meets critical design velocity and depth criteria over the widest possible array of flow conditions.

- Remove the existing timber and rock dam and replace with a reinforced concrete weir spanning the entire main river channel;
- Place fill and rock to provide a flat sloped riffle extending downstream from the dam approximately 1,000 to 2,000 feet;
- Potentially incorporate several rock boulders to break up flow and provide resting places for fish as they swim over the ramp;
- Potentially grout rock on the crest and extending part way down the ramp to protect against ice action; and
- The rough cost estimate for construction of the new concrete weir and the rock ramp varies based on ramp slope and material; for a 1% slope, the estimated cost is \$38 million (2009 price level), including the cost of the removable, rotating screens.



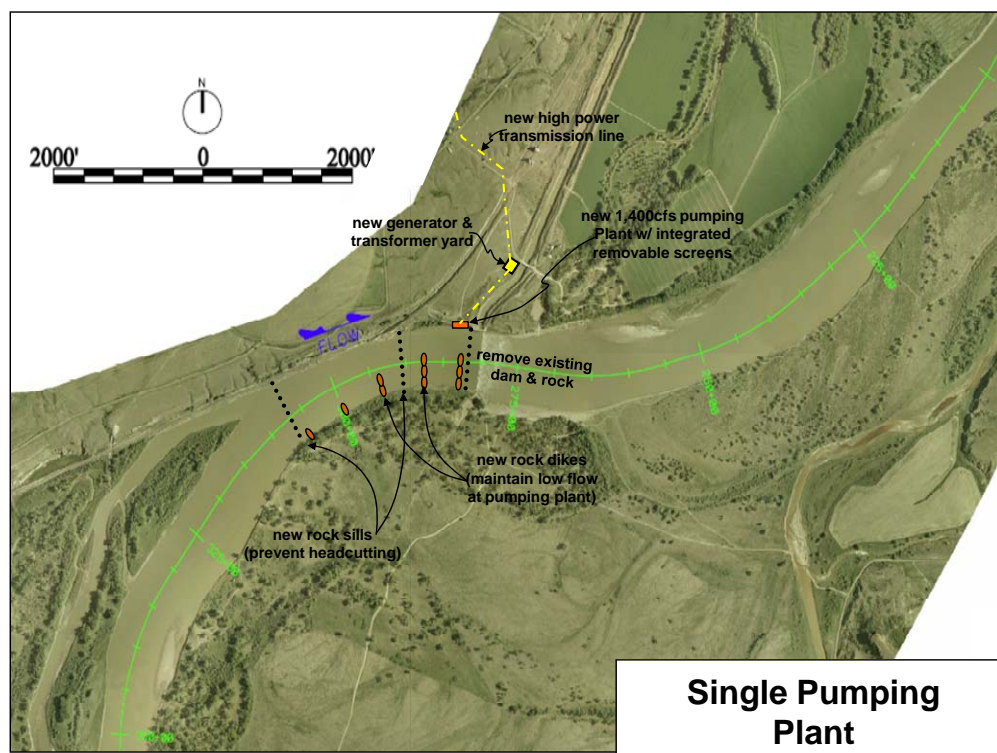
4. Single Pumping Plant.

The idea behind this concept is to construct a pumping plant at the location of the dam to divert flows without the need for a diversion dam. The existing dam would be removed and a new pumping plant would be constructed at the location of the existing headworks to provide the required flow (1,400 cfs). In order to ensure pumping operations under low flow conditions, significant channel engineering would be required to maintain the channel invert adjacent to the pumping plant. Finally, due to the power demand required to operate the pumps a new high power transmission line and transformer yard would be required to support the pumping plant. Also, a high capacity generator would be placed on-site to provide backup power in the event of a power outage.

- New pumping plant with 1,400 cfs capacity at the existing headworks;
- The removable screens would be the only screening alternative appropriate for the pumping plant;
- A minimum of several stabilized rock sills spanning the width of the Yellowstone River main channel would be necessary to prevent headcutting of the main channel once the dam is removed;
- River training dikes and revetment would be constructed in the vicinity of the new pumping plant and upstream to fix the invert of the channel adjacent to the pumping plant for operating purposes; and
- No cost estimate has been developed for this alternative, although pumping plants typically cost >\$50 million and the amount of power demand required to operate the plants would likely exceed \$1 million per year.

VALUE ENGINEERING TEAM STUDY

APPENDIX A: PROJECT DESCRIPTION, PROJECT CRITICAL ISSUES, CONSTRAINTS, AND PERFORMANCE ATTRIBUTES



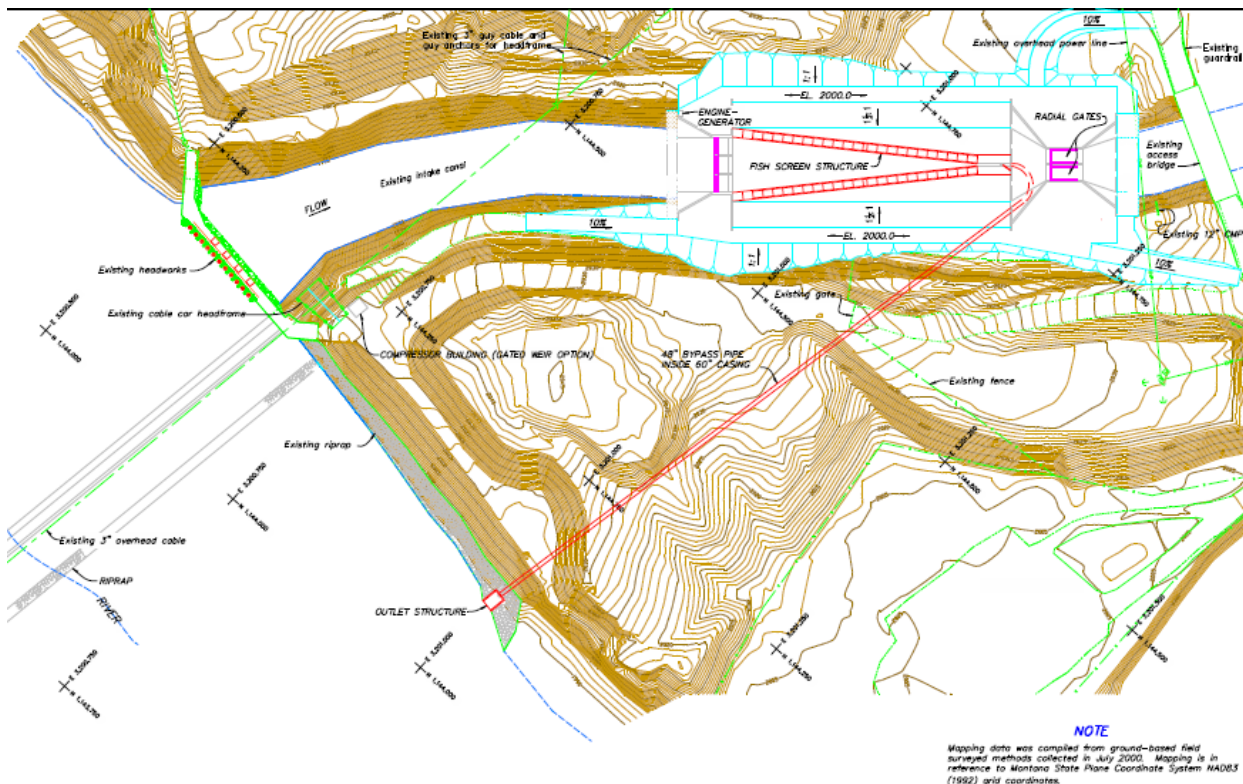
5. V-Shaped Screen

The idea behind this concept is to construct a v-shaped, flat panel screen within the existing canal to provide entrainment protection. The v-shaped screen design is a common technology utilized throughout the West and the Northwest to screen fish from entering irrigation canals. Based on feedback from the fish biologists, this alternative would also incorporate a new trashrack facility riverward of the existing headworks. The function of the trashrack is to prevent debris and adult fish from ever entering the canal and being exposed to the screen. The v-shaped screen and the trashrack would both incorporate automated cleaning devices which could be operated manually or at preset intervals to minimize clogging and provide optimum performance. The v-shaped screen includes a 48-inch diameter bypass pipe to carry the screened juvenile fish back to the main river channel.

- New v-shaped screen within the canal downstream of the headworks;
- Screen utilizes 1.75-millimeter stainless steel wedge wire mesh to screen out forage and juvenile fish;
- 48-inch diameter bypass pipe to carry screened juvenile fish back to main river channel;

VALUE ENGINEERING TEAM STUDY
APPENDIX A: PROJECT DESCRIPTION, PROJECT CRITICAL
ISSUES, CONSTRAINTS, AND PERFORMANCE ATTRIBUTES

- Walking brush and spray cleaning system to keep screens clean and prevent clogging;
- 2-inch trashrack riverward of headworks to screen out large debris and adult and juvenile fish;
- Automated rake system and conveyor to clean trashrack;
- The v-shaped screen and trashrack alternative could be utilized with any of the fish passage alternatives with the exception of the pumping plant; however, it would probably be most suited to the rock ramp alternative if re-use of the existing headworks is preferred. Any alternative involving construction of a new headworks would likely incorporate the removable screens as the screening technology; and
- The rough cost estimate for construction of the new v-shaped screen and the trashrack is approximately \$16 million for the screen and approximately \$12.5 million for the trashrack.



VALUE ENGINEERING TEAM STUDY

APPENDIX A: PROJECT DESCRIPTION, PROJECT CRITICAL ISSUES, CONSTRAINTS, AND PERFORMANCE ATTRIBUTES



**V-Shaped Fish
Screen (cont.)**



6. Removable Rotating Drum Screens

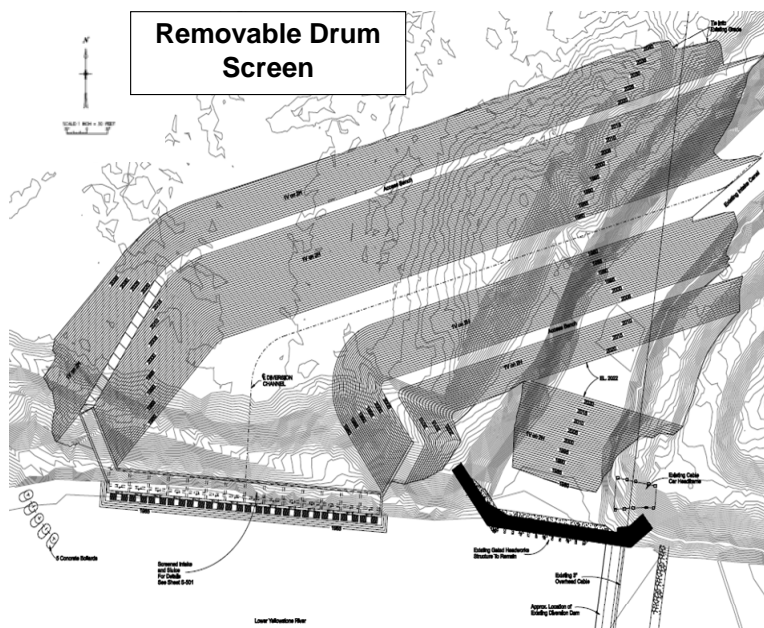
The idea behind this concept is to utilize removable screens to provide entrainment protection. Any screening provided riverward of the existing headworks must be designed to be removed to account for severe ice jams which commonly occur on the Lower Yellowstone River during early spring. The utilization of rotating drum screens which can be raised and lowered on a track is becoming a common screening technology. Each individual screen would be sized to provide 100 cfs of flow resulting in 14 individual screens for 1,400 cfs of flow capacity. The individual screens are 6-foot diameter and approximately 20-feet in length in a T-shape consisting of a manifold in the center and a 6.5-foot section of screen on each end. The screens incorporate a fixed brush on both the interior and exterior of the screen and the drum rotates against the brushes to provide cleaning. Each individual screen slides on a track and can be raised and lowered by use of a wench. The manifold of

VALUE ENGINEERING TEAM STUDY

APPENDIX A: PROJECT DESCRIPTION, PROJECT CRITICAL ISSUES, CONSTRAINTS, AND PERFORMANCE ATTRIBUTES

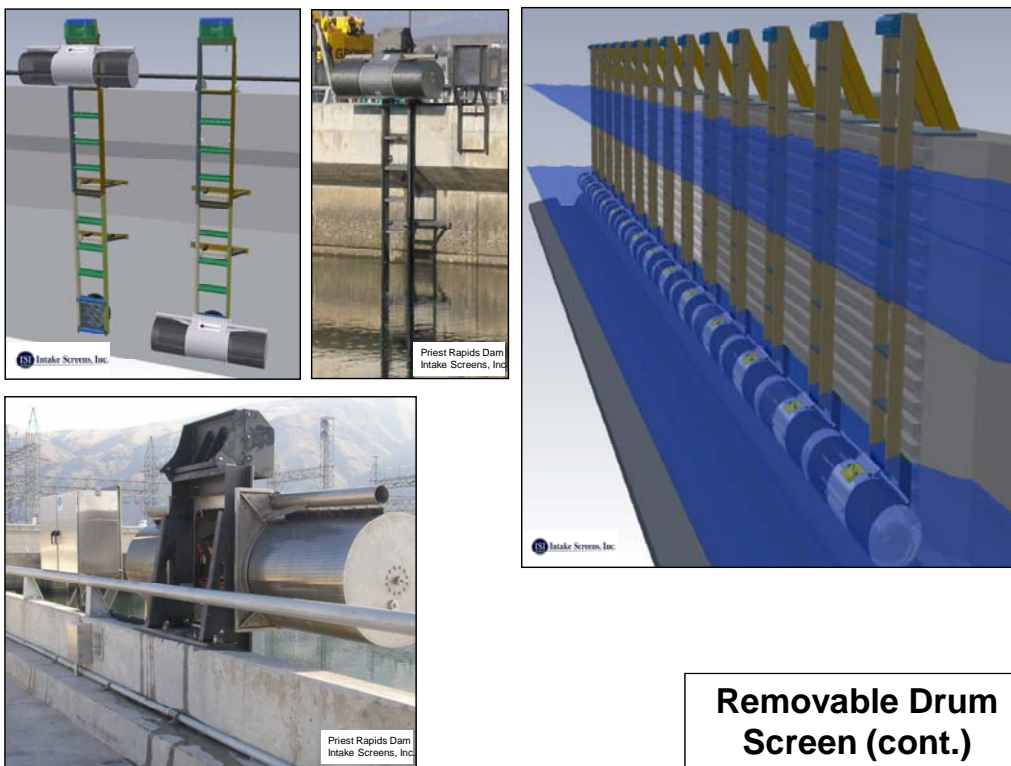
each screen connects to a trash rack on the headworks when the screen is in the lowered position. Due to the length of each of the screens, re-use of the existing headworks is not likely because the existing inlet pipe spacing is not adequate. The riverward location of the removable screens eliminates the need for a trashrack and a bypass pipe since the fish will stay in the main river channel.

- a. New headworks just upstream from the existing headworks;
- b. 14 (fourteen), 6-ft diameter drum screens each approximately 20-feet long;
- c. Drum screen utilizes 1.75-millimeter stainless steel wedge wire mesh to screen out fish;
- d. Internal and external fixed brush cleaning system to keep screens clean and prevent clogging;
- e. Wench and embedded track on headworks to allow ease of raising and lowering screens during non-irrigation season;
- f. The removable screen alternative could be utilized with any of the fish passage alternatives where the alternative would replace the existing headworks; and
- g. The rough cost estimate for construction of the new headworks and removable screens is approximately \$13.2 million (2009).



VALUE ENGINEERING TEAM STUDY

APPENDIX A: PROJECT DESCRIPTION, PROJECT CRITICAL ISSUES, CONSTRAINTS, AND PERFORMANCE ATTRIBUTES



ASSUMED BASELINE DESIGN

In developing alternatives and their cost impacts, a baseline design needs to be assumed or developed for comparison purposes. In this case, the VE team was instructed to utilize the proposed 1% slope rock ramp design concept combined with removable rotating drum screens. This concept consists of replacing the existing dam with a concrete weir and providing a downstream rock ramp at a 1% slope to facilitate passage of pallid sturgeon. The material to be used to construct the ramp is to consist of locally available quarry stone.

The selection of this baseline was in the general consensus of the VE team based on the current status of modeling. The 1% slope was utilized as the base condition to represent the potential average slope of the entire ramp recognizing that the slope will likely vary from very flat at the crest to a steeper slope at the toe. On-going hydraulic modeling will optimize the final slope, but using the 1% slope for quantity and cost estimating was deemed appropriate for this VE study.

PROJECT CONSTRAINTS AND CRITICAL ISSUES

The VE team identified the following critical issues and project constraints during the information gathering phase of the study. This information was used to guide the function analysis and speculation phases of the workshop.

Project Constraints:

- USFWS requires a minimum 50% of width needs to be passable (from velocity/ turbulence point of view) for pallid sturgeon during the migration season (May 1 through July 15).
- Must be able to deliver ~1380 cfs to meet the irrigation needs from mid April to mid October.
- Design within NOAA criteria (5% to 95% river flow during migration season).

Critical Issues:

- Flow velocity and turbulence are critical control points.
- Ice impacts need to be taken into account in design.
- Need to keep fish out of the irrigation channel.
- Fish larvae less than 15 days old will pass through the screens.
- Need to consider fishing access to river at current boat ramp location.
- Need a design that would not create onerous O&M conditions.
- Silt depositions needs to be considered in design.
- Concerned about long-term maintenance of rock ramp and low flow channels.
- Constructibility is complicated by state park constrictions and tight quarters.
- Construction of new dam (weir or retaining wall) will be complex.
- Control of water during construction is a complex issue and cannot interfere with delivery of irrigation water.
- Delivery of material for rock ramp will be difficult.
- Cannot work on cofferdam during migration season.
- In-water work construction season will be short.
- Need to survey existing sand bar for least terns.
- Need to survey for cultural resource sites.
- Need to be concerned about water quality during construction.
- Testing sediments above dam for contaminants.
- Would prefer a dam crest that accommodates full canal under drought conditions.

VALUE ENGINEERING TEAM STUDY

APPENDIX A: PROJECT DESCRIPTION, PROJECT CRITICAL ISSUES, CONSTRAINTS, AND PERFORMANCE ATTRIBUTES

- Real estate acquisition needs may impact selected alternative.
- Could encounter remains of prehistoric creatures (e.g. dinosaurs) during construction.
- Time is a concern (pallid sturgeon could be extinct in the area by 2018); want system to be operational by migration season in 2013.
- Use RFP process for screen component; may consider design-build but not preferred approach.
- Screens will require some lead time to acquire – perhaps 6 months.
- Significant changes to selected options could impact current status of NEPA process; would not want to expand field of alternatives.
- This project is the first of its kind for pallid sturgeon, so setting a precedent.
- Construction of rock ramp will require a significantly large volume of rock.

Performance Attributes:

1. Fish Performance (FP)

A primary objective of the project is to protect the endangered pallid sturgeon while providing a passageway past the irrigation dam. This objective should be accomplished in such a way as to enhance the natural appearance of the fishway while providing the ability to attract pallid sturgeon. This attribute also incorporates the need to create an environment with the correct range of flow velocity, swim speed and turbidity suitable for sturgeon transfer. In addition, the design should minimize fish entrainment into the irrigation canal. The preferred option would be one which would allow for pallid sturgeon passage, and non-entrainment in the irrigation canal.

2. Water Delivery Reliability (WDR)

The non-interrupted delivery of water through an irrigation diversion structure to local users must be maintained at the current rate, volume and quality, during the needed time period, without being diminished through implementation of a fish passage/entrainment alternative.

3. Engineering Design & Constructibility (EDC)

The translation of design to construction is not always as trouble-free or consistent as the designer hopes. Construction complexity that will assess specific areas of construction difficulty include planned process of installation, risk reduction and the potential for change orders, claims and work stoppages; logistics; adverse geotechnical conditions, impacts to schedule; etc. For each proposed alternative, the VE team member should assess how the design is altered to improve the construction process and enhance construction performance. Other concerns and limitations regarding the construction season (weather and fish migration) need to be addressed. Any option that simplifies the construction process while reducing risks and minimizing impacts to irrigation canal operations is preferred.

4. Operations & Maintenance (O&M)

Operational considerations include level of service relative to meeting facility objectives (fish passage/entrainment and irrigation water delivery) quickly and efficiently without loss of capacity under all levels of riverine flow and climatic conditions

An assessment of the long-term maintainability of the fish passage/entrainment/irrigation delivery facility(s) includes the overall durability, longevity and maintainability of structures, equipment and systems; ease of maintenance; accessibility and safety considerations for maintenance personnel.

The application of proven technologies, within known maintenance and operation parameters, may be preferred over new, more experimental technologies.

5. Cost Effectiveness (CE)

In suggesting a particular alternative, the VE team should make an approximate, qualitative assessment of how the recommendation might impact the overall cost of the project, in terms of first cost and life cycle costs (where appropriate). The ease with which an alternative can be implemented should be assessed as this also impact the relative cost.

An alternative to the current design options may be assessed in two ways:

- Does the alternative produce a project at lower cost but with an equivalent or greater benefit to the current design(s)?
- Does the proposed alternative better meet the Federal project objectives and schedule (within authorized purposes) for the equivalent cost of the current design(s)?

A positive response to either of these options would result in an improvement in the Cost Effectiveness performance attribute.

VALUE ENGINEERING TEAM STUDY

APPENDIX A: PROJECT DESCRIPTION, PROJECT CRITICAL ISSUES,
CONSTRAINTS, AND PERFORMANCE ATTRIBUTES

PERFORMANCE ATTRIBUTES SCALES <i>Lower Yellowstone River Irrigation Dam, Fish Protection and Passage</i>					
Performance Attribute Scales					
Rating	Fish Performance (FP)	Water Delivery Reliability (WDR)	Engineering Design & Constructibility (EDC)	Operations & Maintenance (OM)	Cost Effectiveness (CE)
2	Alternative Concept is strongly preferred.				
1	Alternative Concept is moderately preferred.				
0	Concepts are equally preferred.				
-1	Baseline Concept is moderately preferred.				
-2	Baseline Concept is very strongly preferred.				

VE COST ASSUMPTIONS

VALUE ENGINEERING TEAM STUDY
APPENDIX B: VE Cost Assumptions

The VE Team was provided with preliminary/planning level cost estimates for various options under consideration to use as a guide in making the general comparisons associated with individual alternatives. For the purpose of this study, the option consisting of replacing the existing dam with a concrete weir and a downstream 1% rock ramp composed of quarried boulders would serve as the baseline design. This would include the removable, rotating screen and headworks. The VE team did not make any judgments as to the accuracy or completeness of the estimate. The current total project cost estimate, as of May 26, 2009, is \$38,433,526.

The revised cost estimate was provided to the team; however, it is lengthy and not reproduced in this report. In its place, a single page recap estimate is provided below. The values used in this estimate (unit and lump sum) were also used in the proposal cost estimates, supplemented by information provided by suppliers, contractors and/or available from similar applications revealed in other value engineering studies or completed projects.

Proposal cost estimates compare relative items of the current design and proposed change for the sole purpose of estimating the net difference between the two options. In several cases, the estimates do not include the total feature cost but only those components that are changed by the proposal.

A cost model showing how the individual cost items in the preliminary estimate was prepared for the 1% rock ramp baseline design and is reproduced below. This model shows that over 93% of the project costs are contained in four major items: gated intake structure (~41%), rock ramp riprap (~35%), diversion of water through cofferdams and pumping (~10%), and the new concrete dam/weir (~7%).

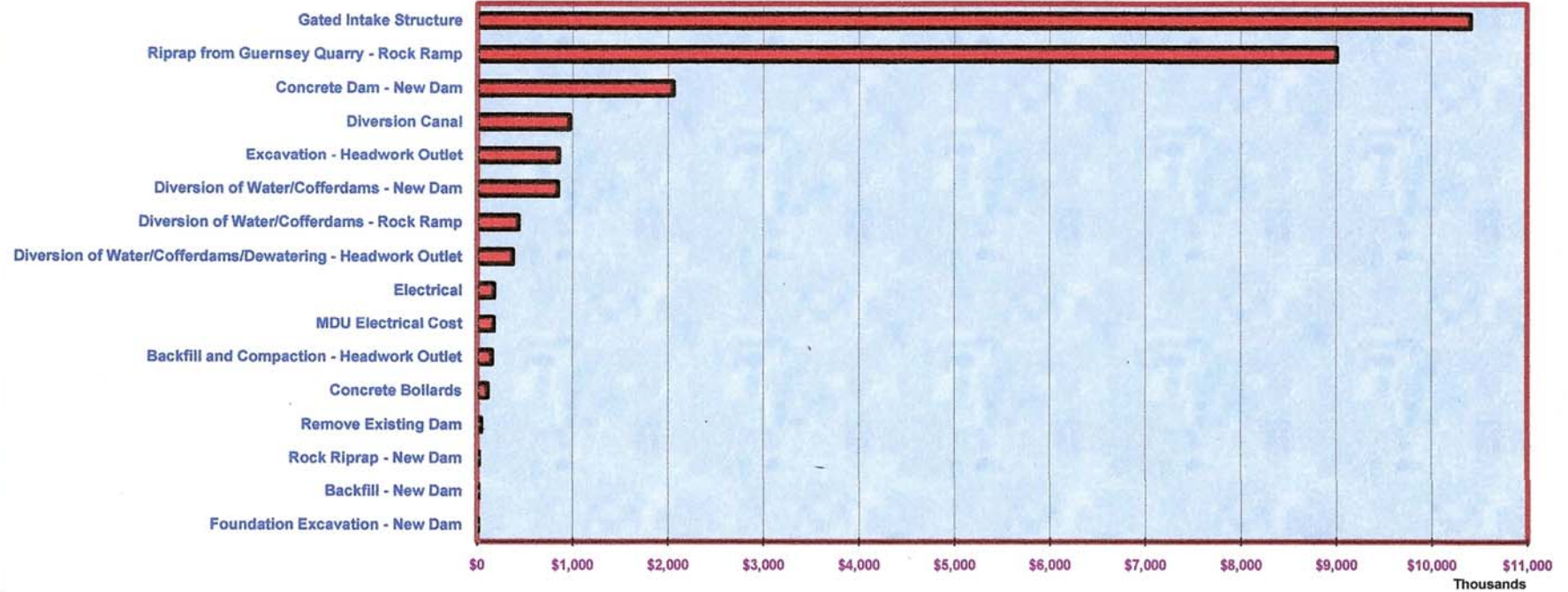
COST HISTOGRAM- Project Cost

PROJECT: 1% Rock Ramp w/Quarried Boulders - Weir Option - Lower Yellowstone Irrigation Dam

PROJECT ELEMENT	COST	PERCENT	CUMULATIVE PERCENT
Gated Intake Structure	\$ 10,407,265.62	40.67%	40.67%
Riprap from Guernsey Quarry - Rock Ramp	\$ 9,003,776.12	35.19%	75.86%
Concrete Dam - New Dam	\$ 2,049,657.72	8.01%	83.87%
Diversion Canal	\$ 964,849.13	3.77%	87.64%
Excavation - Headwork Outlet	\$ 851,073.79	3.33%	90.97%
Diversion of Water/Cofferdams - New Dam	\$ 842,569.51	3.29%	94.26%
Diversion of Water/Cofferdams - Rock Ramp	\$ 429,922.49	1.68%	95.94%
Diversion of Water/Cofferdams/Dewatering - Headwork Outlet	\$ 370,078.74	1.45%	97.39%
Electrical	\$ 173,338.08	0.68%	98.06%
MDU Electrical Cost	\$ 170,324.82	0.67%	98.73%
Backfill and Compaction - Headwork Outlet	\$ 152,359.09	0.60%	99.33%
Concrete Bollards	\$ 105,936.44	0.41%	99.74%
Remove Existing Dam	\$ 38,286.93	0.15%	99.89%
Rock Riprap - New Dam	\$ 14,119.04	0.06%	99.94%
Backfill - New Dam	\$ 9,707.22	0.04%	99.98%
Foundation Excavation - New Dam	\$ 4,627.78	0.02%	100.00%
Contract Cost	\$ 25,587,893	100.00%	
Escalation 0%	\$ -		
Contingency 30%	\$ 7,676,368		
E& D 9%	\$ 2,993,783		
S&A 6%	\$ 2,175,483		
PROJECT COST	\$ 38,433,526	Comp Mark-up:	50%

COST HISTOGRAM- Project Cost

PROJECT: 1% Rock Ramp w/Quarried Boulders - Weir Option - Lower Yellowstone Irrigation Dam



Print Date Tue 26 May 2009
Eff. Date 5/26/2009

U.S. Army Corps of Engineers
Project CI12900: Rock Ramps
New Report

Time 14:05:43

RECAP Page 1

Description	ContractCost	ProjectCost
RECAP	28,262,956.10	42,451,525.31
	28,262,956.0955	42,451,525.3146
1% Rock Ramp w/quarried boulders	28,262,956.10	42,451,525.31
	5,634,031.7764	8,462,428.4088
New Concrete Dam	5,634,031.78	8,462,428.41
	2,675,063.5744	4,017,998.9900
Retaining Wall Option	2,675,063.57	4,017,998.99
	2,958,968.2020	4,444,429.4188
Weir Option	2,958,968.20	4,444,429.42
	9,433,698.6141	14,169,603.9923
Rock Ramp, 1% slope w/quarry stone	9,433,698.61	14,169,603.99
	9,003,776.1205	13,523,851.8085
Riprap from Guernsey quarry	9,003,776.12	13,523,851.81
Diversion of Water	429,922.49	645,752.18
	13,195,225.7050	19,819,492.9134
Headwork Outlet	13,195,225.71	19,819,492.91
	1,003,432.8799	1,507,176.2543
Earthwork	1,003,432.88	1,507,176.25
	370,078.7369	555,865.6644
Diversion of Water	370,078.74	555,865.66
	10,407,265.6245	15,631,921.1133
Gated Intake Structure	10,407,265.62	15,631,921.11
	964,849.1306	1,449,222.6911
Diversion Canal	964,849.13	1,449,222.69
	21,187.2883	31,823.7308
Concrete Bollards	105,936.44	159,118.65
	173,338.0760	260,357.2569
Electrical	173,338.08	260,357.26
	170,324.8155	255,831.2794
MDU Electrical Cost	170,324.82	255,831.28

Labor ID: Means EQ ID: EP07R04

Currency in US dollars

TRACES MII Version 3.0

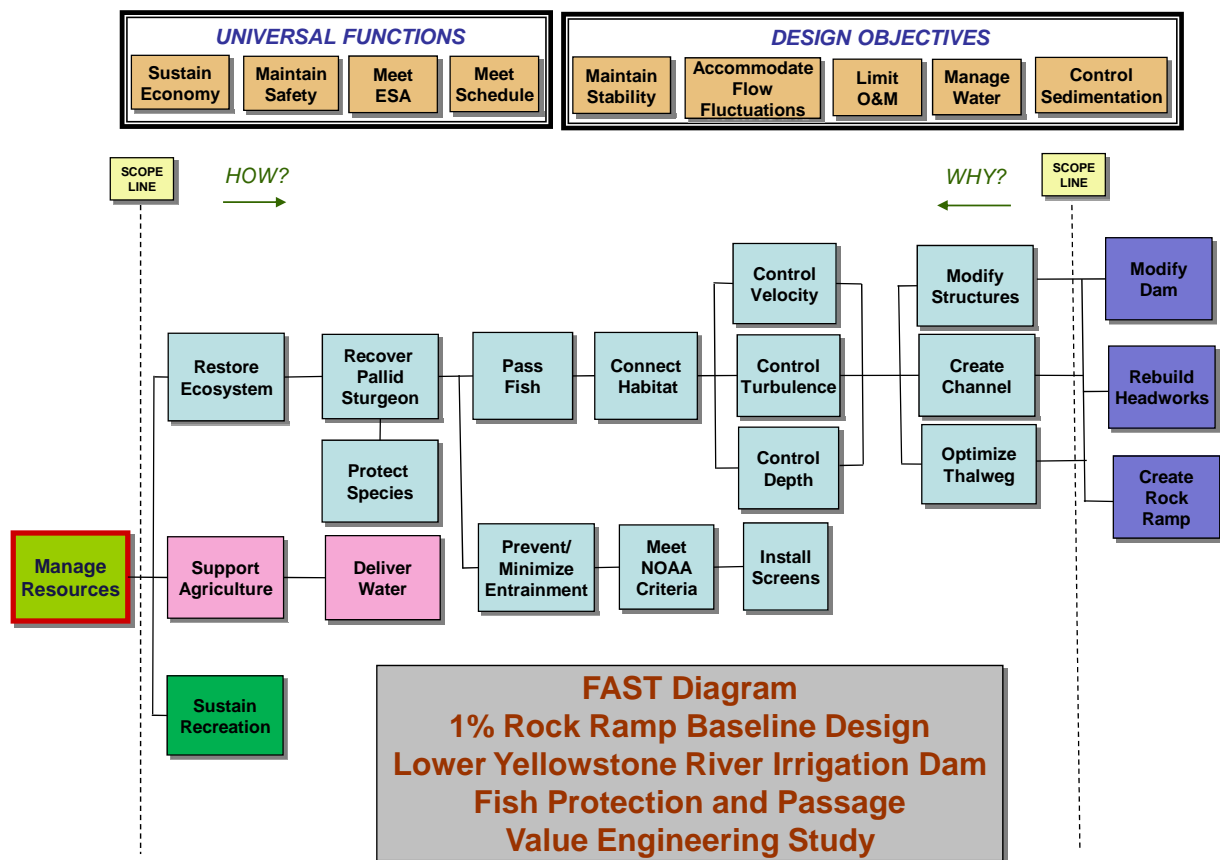
FUNCTION ANALYSIS SYSTEM TECHNIQUE (FAST) DIAGRAM

PROJECT FUNCTIONS

- Protect Species
- Manage Water
- Restore Ecosystem
- Support Fish
- Create Channel
- Modify Structures
- Meet Schedule
- Recover Pallid Sturgeon
- Limit O&M
- Maintain Fish Resource
- Maintain Water Resource
- Pass Fish
- Minimize Entrainment
- Meet ESA
- Connect Habitat
- Control Velocity
- Control Turbulence
- Control Depth
- Maintain Safety
- Optimize Thalweg
- Deliver Water
- Sustain Recreation
- Pass Ice
- Maintain Stability
- Control Sedimentation
- Support Screens
- Support Agriculture
- Support Economy
- Accommodate Flow Fluctuations
- Manage Resources
- Meet NOAA Criteria
- Modify Dam
- Rebuild Headworks
- Create Rock Ramp
- Construct Bypass Channel

VALUE ENGINEERING TEAM STUDY

APPENDIX C: FUNCTION ANALYSIS SYSTEM TECHNIQUE (FAST) DIAGRAM



SPECULATION LIST/ IDEA EVALUATION

VALUE ENGINEERING TEAM STUDY
APPENDIX D: SPECULATION LIST/IDEA EVALUATION

The list of ideas created during the speculation phase of the workshop was recorded by the team facilitator. The Idea Evaluation Form containing all of the ideas, and the rating method applied to each idea, is presented in the following pages.

Those ideas that were considered by the team to be feasible were then assigned a recommendation for development as follows:


- ♦ P = Proposal
- ♦ C = Comment or Suggestion
- ♦ BD = Being Done or Being Considered

The balance of the ideas were assigned:

- ♦ X = Rejected or Outside Project Scope


In evaluating the suggestions during the development phase, each writer then expressed the advantages and disadvantages in the individual suggestions to better describe the characteristics of the alternative. The reader is encouraged to read each suggestion independently for complete information.

The reader will note that, as the evaluation process proceeded, many of the ideas were found to have common themes, and were therefore combined.


IDEA EVALUATION Lower Yellowstone River Irrigation Dam, Fish Protection and Passage									
Ideas		Performance Attributes					Advantages	DISADVANTAGES	PROPOSAL (P), Comment (C), BEING DONE (BD), OR REJECT (X)
No.	Description	FP	WDR	EDC	OM	CE			
1	Grout existing dam rather than replace it	0	0	-2	-1	+1	<ul style="list-style-type: none">• Lower cost?	<ul style="list-style-type: none">♦ Need to contain grout from flowing downstream♦ Cannot assure all voids are filled♦ Rougher approach surface	X
2	Use existing cable system to survey dam geometry	0	0	+1	0	0	<ul style="list-style-type: none">• Improve knowledge base for design	<ul style="list-style-type: none">♦ Need to consider safety of system	X
3	Use sheet piling instead of concrete dam	0	0	0	-1		<ul style="list-style-type: none">♦ Potentially lower cost♦ May be able to leave existing dam in place♦ Do not need to dewater (less cofferdam)	<ul style="list-style-type: none">♦ May encounter resistance to driving sheeting♦ Want sloped face to allow ice to flow over♦ May need corrosion protection♦ May encounter resistance from Montana DEQ♦ Could interfere with downstream migration	X

Performance Attributes: Significant Improvement +2, +1, 0, -1, -2 Significant Degradation


Fish Performance (FP); Water Delivery Reliability (WDR); Engineering Design & Construction (EDC); Operations & Maintenance (OM); Cost Effectiveness (CE)

IDEA EVALUATION <i>Lower Yellowstone River Irrigation Dam, Fish Protection and Passage</i>									
<i>Ideas</i>		Performance Attributes					Advantages	DISADVANTAGES	PROPOSAL (P), Comment (C), BEING DONE (BD), OR REJECT (X)
No.	Description	FP	WDR	EDC	OM	CE			
4	Use pre-cast concrete box section for dam replacement	0	0	+1	0	+1	<ul style="list-style-type: none"> • Float in sections or bring in by rail • Do not need to dewater • Do not need to place concrete in adverse conditions • Can fill with ballast or concrete once in place • Can pre-fabricate in advance • Can be a contractor option • Works best if new weir upstream of existing dam 	<ul style="list-style-type: none"> • Need to have prepared base • Need to assure that ice forces can be resisted • Need to be tied together to maintain crest elevation and location 	P
5	Incorporate water intake structure (for irrigation) into dam	0	-2	-2	-1	+1	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> • Inadequate volume available 	X

Performance Attributes: Significant Improvement +2, +1, 0, -1, -2 Significant Degradation
Fish Performance (FP); Water Delivery Reliability (WDR); Engineering Design & Construction (EDC); Operations & Maintenance (OM); Cost Effectiveness (CE)


IDEA EVALUATION <i>Lower Yellowstone River Irrigation Dam, Fish Protection and Passage</i>									
<i>Ideas</i>		Performance Attributes					Advantages	DISADVANTAGES	PROPOSAL (P), Comment (C), BEING DONE (BD), OR REJECT (X)
No.	Description	FP	WDR	EDC	OM	CE			
6	Consult with Walla Walla District for write-ups regarding available fish screens	0	0	+1	+1	+1	<ul style="list-style-type: none"> Assure that right system is selected and available 	<ul style="list-style-type: none"> None apparent 	C
7	Net fish and truck them around the dam	-2	0	+2	-2	-2	<ul style="list-style-type: none"> None apparent 	<ul style="list-style-type: none"> Not practical 	X
8	Construct a secondary bypass between headworks and top of V-screen to allow adult fish to reenter the river instead of a trash rack	-2	-1	+2	0	+1	<ul style="list-style-type: none"> Does allow an escape route Do not need the river side screen May be lower cost by eliminating trash rack 	<ul style="list-style-type: none"> Still potential for injury as adult fish pass through pipe No guarantee they will exit channel quickly May be opposed by BRT May not have enough head to drive flow Requires higher diversion rate 	X

Performance Attributes: Significant Improvement +2, +1, 0, -1, -2 Significant Degradation
Fish Performance (FP); Water Delivery Reliability (WDR); Engineering Design & Construction (EDC); Operations & Maintenance (OM); Cost Effectiveness (CE)


IDEA EVALUATION Lower Yellowstone River Irrigation Dam, Fish Protection and Passage									
<i>Ideas</i>		Performance Attributes					Advantages	DISADVANTAGES	PROPOSAL (P), Comment (C), BEING DONE (BD), OR REJECT (X)
No.	Description	FP	WDR	EDC	OM	CE			
9	Utilize synthetic materials to construct ramp	0	0	0	+1	-2	<ul style="list-style-type: none"> To reduce cost with similar function Can place in wet Would better resist ice forces Can design for a more uniform product and roughness 	<ul style="list-style-type: none"> Need a smooth base Less aesthetic than rock BRT may object Need stainless steel cable Too costly 	P
10	Build less than full-width ramp	-2	0	-1	0	0	<ul style="list-style-type: none"> Less rock required 	<ul style="list-style-type: none"> BRT may object Unproven technology 	X
11	Use a bubble barrier at the headworks to limit entrainment of fish	-1	0	+2	-1	+2	<ul style="list-style-type: none"> 	<ul style="list-style-type: none"> May attract sturgeon May not work 	X
12	Investigate constructibility of concrete dam	0	0	+1	+1	+1	<ul style="list-style-type: none"> Assure that we minimize construction issues 	<ul style="list-style-type: none"> None apparent 	See 62

Performance Attributes: Significant Improvement +2, +1, 0, -1, -2 Significant Degradation

Fish Performance (FP); Water Delivery Reliability (WDR); Engineering Design & Construction (EDC); Operations & Maintenance (OM); Cost Effectiveness (CE)

IDEA EVALUATION <i>Lower Yellowstone River Irrigation Dam, Fish Protection and Passage</i>									
Ideas		Performance Attributes					Advantages	DISADVANTAGES	PROPOSAL (P), Comment (C), BEING DONE (BD), OR REJECT (X)
No.	Description	FP	WDR	EDC	OM	CE			
13	Consider a narrower ramp that extends both upstream and downstream of dam	-2	0	-1	0	0	<ul style="list-style-type: none">Less rock required	<ul style="list-style-type: none">BRT may objectUnproven technology	X
14	Construct/place concrete in the wet	0	0	-1	-1	+1	<ul style="list-style-type: none">Eliminates cofferdams	<ul style="list-style-type: none">Concerned about containing concrete in a flowing water situationQuality control is more difficultWould need to time it for low flowDEQ will object.	X
15	Identify best value for fish screen	+1	0	+1	+1	+1	<ul style="list-style-type: none">Would assure best choice for this project	<ul style="list-style-type: none">None apparent	C


Performance Attributes: Significant Improvement +2, +1, 0, -1, -2 Significant Degradation
Fish Performance (FP); Water Delivery Reliability (WDR); Engineering Design & Construction (EDC); Operations & Maintenance (OM); Cost Effectiveness (CE)

IDEA EVALUATION									
Lower Yellowstone River Irrigation Dam, Fish Protection and Passage									
Ideas		Performance Attributes					Advantages	DISADVANTAGES	PROPOSAL (P), Comment (C), BEING DONE (BD), OR REJECT (X)
No.	Description	FP	WDR	EDC	OM	CE			


16	Design a screen that will work with existing headworks on river	0	-2	-1	-1	+1	<ul style="list-style-type: none"> Saves real estate Would not need new headworks 	<ul style="list-style-type: none"> Historical property issues Would reduce volume of flow entering pipes Integrity of structure is suspect Would need to be combined with farming conservation 	X
17	Construct an earthen dam to replace the concrete wall at the headworks	0	0	0	0	+1	<ul style="list-style-type: none"> Saving structural concrete Shorter construction duration May get better seal between screen and manifold 	<ul style="list-style-type: none"> Need to design berm and rails to resist ice forces More difficult to maintain shut off gates behind screens Need to address settlement 	P
18	Utilize railroad spur to bring in construction materials						<ul style="list-style-type: none"> Currently being considered 		BD
19	Construct headwall down channel from fish screen	0	0	-1	-1	-1	<ul style="list-style-type: none"> Fish are not exposed to pressured pipes passing through headworks if V-screen is selected 	<ul style="list-style-type: none"> May add cost to project Need trash rack or debris boom 	X

Performance Attributes: Significant Improvement +2, +1, 0, -1, -2 Significant Degradation

Fish Performance (FP); Water Delivery Reliability (WDR); Engineering Design & Construction (EDC); Operations & Maintenance (OM); Cost Effectiveness (CE)


IDEA EVALUATION <i>Lower Yellowstone River Irrigation Dam, Fish Protection and Passage</i>									
Ideas		Performance Attributes					Advantages	DISADVANTAGES	PROPOSAL (P), Comment (C), BEING DONE (BD), OR REJECT (X)
No.	Description	FP	WDR	EDC	OM	CE			
20	Construct a weir to divert higher in the water column	+1	0	-1	0	-1	<ul style="list-style-type: none"> • Takes water from top reducing fish reaching screens • Reduce amount of sediment entering channel • Could be open on downstream end to allow any trapped fish to escape • Wall could be concrete or vinyl sheet pile • Could be added to project in the future 	<ul style="list-style-type: none"> • Additional structure in project 	C
21	Replace existing dam with a bladder dam	-2	0	+2	-1	0	•	<ul style="list-style-type: none"> • Not resistant to ice • May impede fish passage 	X
22	Construct bladder dam on upstream side of existing dam	-2	0	+2	-1	0	•	<ul style="list-style-type: none"> • Not resistant to ice • May impede fish passage 	X

Performance Attributes: Significant Improvement +2, +1, 0, -1, -2 Significant Degradation
Fish Performance (FP); Water Delivery Reliability (WDR); Engineering Design & Construction (EDC); Operations & Maintenance (OM); Cost Effectiveness (CE)


IDEA EVALUATION <i>Lower Yellowstone River Irrigation Dam, Fish Protection and Passage</i>									
<i>Ideas</i>		Performance Attributes					Advantages	DISADVANTAGES	PROPOSAL (P), Comment (C), BEING DONE (BD), OR REJECT (X)
No.	Description	FP	WDR	EDC	OM	CE			
23	Utilize a traditional fish ladder for upstream fish passage	-2	0	0	+2	+2	<ul style="list-style-type: none"> Lower cost 	<ul style="list-style-type: none"> May not attract to ladder entrance Not preferred by BRT or USFWS 	X
24	Use a barrage (gallery of sluice gates) instead of a traditional dam	-2	0	0	-1	0	<ul style="list-style-type: none"> Would replace ramp 	<ul style="list-style-type: none"> Would not provide desired fish passage results 	X
25	Develop an off-stream reservoir to deliver water to the Irrigation District	+2	0	-1	+1	-2	<ul style="list-style-type: none"> Could remove dam 	<ul style="list-style-type: none"> Need real estate Would be quite large Would pump river water during non-irrigation Evaporation losses Need fish screen 	X
26	Build a pallid sturgeon education facility on site	0	0	0	0	0	<ul style="list-style-type: none"> Interpretive center for users 	<ul style="list-style-type: none"> None apparent 	C

Performance Attributes: Significant Improvement +2, +1, 0, -1, -2 Significant Degradation

Fish Performance (FP); Water Delivery Reliability (WDR); Engineering Design & Construction (EDC); Operations & Maintenance (OM); Cost Effectiveness (CE)


IDEA EVALUATION <i>Lower Yellowstone River Irrigation Dam, Fish Protection and Passage</i>									
Ideas		Performance Attributes					Advantages	DISADVANTAGES	PROPOSAL (P), Comment (C), BEING DONE (BD), OR REJECT (X)
No.	Description	FP	WDR	EDC	OM	CE			
27	Construct an infiltration gallery	+1	-1	-2	-2	-2	<ul style="list-style-type: none"> Replaces fish screens 	<ul style="list-style-type: none"> Would need to be very large Need to pump water into canal Major O&M issues due to high sediment loads 	X
28	Pump groundwater to supplement irrigation demand	0	-1	-1	-2	-1	<ul style="list-style-type: none"> None apparent 	<ul style="list-style-type: none"> Not feasible due to lack of sufficient groundwater High initial and O&M cost 	X
29	Purchase water rights to reduce irrigation need						<ul style="list-style-type: none"> 	<ul style="list-style-type: none"> Not politically acceptable 	X
30	Remove dam and exchange for Missouri River water	+2					<ul style="list-style-type: none"> 	<ul style="list-style-type: none"> Not practical Missouri River is ~70 miles away Need to screen on Missouri River side 	X

Performance Attributes: Significant Improvement +2, +1, 0, -1, -2 Significant Degradation
Fish Performance (FP); Water Delivery Reliability (WDR); Engineering Design & Construction (EDC); Operations & Maintenance (OM); Cost Effectiveness (CE)

IDEA EVALUATION Lower Yellowstone River Irrigation Dam, Fish Protection and Passage									
Ideas		Performance Attributes					Advantages	DISADVANTAGES	PROPOSAL (P), Comment (C), BEING DONE (BD), OR REJECT (X)
No.	Description	FP	WDR	EDC	OM	CE			
31	Use sediment-filled geotubes to create dam	0	0	+2	-1	+2	<ul style="list-style-type: none">• Use less rock• Use sediment from excavation work• Can cover with concrete filled mat or pre-cast slabs• May be able to construct in wet	<ul style="list-style-type: none">• Could experience some distortion over time• May have some water quality issues with suspended sediment• Not considered to be practical	X
32	Use sediment-filled geotubes to create ramp	0	0	+2	-1	+2	<ul style="list-style-type: none">• Use less rock• Use sediment from excavation work• Can cover with rock• May be able to construct in wet	<ul style="list-style-type: none">• Could experience some distortion over time• May have some water quality issues with suspended sediment	P
33	Use concrete-filled geotubes to construct ramp	0	0	+2	-1	-2	<ul style="list-style-type: none">• Use less rock• Can cover with rock• May be able to construct in wet	<ul style="list-style-type: none">• Could experience some distortion over time• May have some water quality issues with suspended sediment• Too costly	X


Performance Attributes: Significant Improvement +2, +1, 0, -1, -2 Significant Degradation

Fish Performance (FP); Water Delivery Reliability (WDR); Engineering Design & Construction (EDC); Operations & Maintenance (OM); Cost Effectiveness (CE)

IDEA EVALUATION Lower Yellowstone River Irrigation Dam, Fish Protection and Passage									
<i>Ideas</i>		Performance Attributes					Advantages	DISADVANTAGES	PROPOSAL (P), Comment (C), BEING DONE (BD), OR REJECT (X)
No.	Description	FP	WDR	EDC	OM	CE			
34	Put irrigation canals into a pipe system						•	• Not practical	X
35	Line canal	0	+1	-1	-1	-2	• Reduce infiltration loss	• May be cost prohibitive	X
36	Use multiple pumping stations	+2	0	-2	-2	-2	• Remove dam	• O&M is unfavorable • High power demand • Need more real estate • Need to bring in power infrastructure • Complicates screen design • More stability and sediment transport issues	X
37	Reconstruct Lower Yellowstone River from intake to the mouth to increase larval drift distance						•	• Prohibitively expensive • Politically unacceptable	X

Performance Attributes: Significant Improvement +2, +1, 0, -1, -2 Significant Degradation


Fish Performance (FP); Water Delivery Reliability (WDR); Engineering Design & Construction (EDC); Operations & Maintenance (OM); Cost Effectiveness (CE)

IDEA EVALUATION <i>Lower Yellowstone River Irrigation Dam, Fish Protection and Passage</i>									
Ideas		Performance Attributes					Advantages	DISADVANTAGES	PROPOSAL (P), Comment (C), BEING DONE (BD), OR REJECT (X)
No.	Description	FP	WDR	EDC	OM	CE			

38	Increase river roughness to increase larval drift time						•	• Prohibitively expensive	X
39	Remove Garrison Dam						•	• Prohibitively expensive • Politically unacceptable	X
40	Remove Fort Peck Dam						• Fish would not use Lower Yellowstone River	• Not practical	X
41	Incorporate a fish hatchery into project above the dam						•	•	BD
42	Provide off-channel larval rearing areas						•	• Not practical	X
43	Pay fisherman to relocate pallid sturgeon above dam						•	• Not practical	X

Performance Attributes: Significant Improvement +2, +1, 0, -1, -2 Significant Degradation


Fish Performance (FP); Water Delivery Reliability (WDR); Engineering Design & Construction (EDC); Operations & Maintenance (OM); Cost Effectiveness (CE)

IDEA EVALUATION									
Lower Yellowstone River Irrigation Dam, Fish Protection and Passage									
Ideas		Performance Attributes					Advantages	DISADVANTAGES	PROPOSAL (P), Comment (C), BEING DONE (BD), OR REJECT (X)
No.	Description	FP	WDR	EDC	OM	CE			

44	Utilize series of wedge-shaped grade control structures as part of a rock ramp	-1	0	-2	+1	-1	<ul style="list-style-type: none"> Would improve ramp stability 	<ul style="list-style-type: none"> More material Difficult to construct 	C
45	Ban fishing in the Lower Yellowstone River						<ul style="list-style-type: none"> 	<ul style="list-style-type: none"> Not politically acceptable 	X
46	Incorporate a kayak run into the rock ramp design	0	0	0	0	0	<ul style="list-style-type: none"> Improves recreational opportunities 	<ul style="list-style-type: none"> Need access point above dam 	C
47	Develop an acoustic barrier to limit entrainment						<ul style="list-style-type: none"> 	<ul style="list-style-type: none"> Not effective 	X
48	Use a fish elevator/conveyor or Archimedes screw to move fish upstream						<ul style="list-style-type: none"> 	<ul style="list-style-type: none"> Could injur fish Not practical 	X
49	Convert to dry land farming						<ul style="list-style-type: none"> 	<ul style="list-style-type: none"> Not practical 	X


Performance Attributes: Significant Improvement +2, +1, 0, -1, -2 Significant Degradation

Fish Performance (FP); Water Delivery Reliability (WDR); Engineering Design & Construction (EDC); Operations & Maintenance (OM); Cost Effectiveness (CE)

IDEA EVALUATION <i>Lower Yellowstone River Irrigation Dam, Fish Protection and Passage</i>									
<i>Ideas</i>		Performance Attributes					Advantages	DISADVANTAGES	PROPOSAL (P), Comment (C), BEING DONE (BD), OR REJECT (X)
No.	Description	FP	WDR	EDC	OM	CE			
50	Use a screen that will sluice the fish above the dam						•	• Not practical	X
51	Pass fish through dam						•	• Not practical	X
52	Divert water with a large water wheel						•	• Not practical	X
53	Put turbine in canal to generate electricity						•	• Not practical	X
54	Use an alternate intake that pipes back to the channel upstream of the dam						•	<ul style="list-style-type: none"> • Still need a dam, albeit lower height • Too much large diameter pipe • Impacts railroad 	X


Performance Attributes: Significant Improvement +2, +1, 0, -1, -2 Significant Degradation

Fish Performance (FP); Water Delivery Reliability (WDR); Engineering Design & Construction (EDC); Operations & Maintenance (OM); Cost Effectiveness (CE)

IDEA EVALUATION Lower Yellowstone River Irrigation Dam, Fish Protection and Passage									
Ideas		Performance Attributes					Advantages	DISADVANTAGES	PROPOSAL (P), Comment (C), BEING DONE (BD), OR REJECT (X)
No.	Description	FP	WDR	EDC	OM	CE			
55	Construct a new rock dam in lieu of a concrete dam	-1	0	+1	-2	+2	<ul style="list-style-type: none">• If at same location, continue to maintain with cable• Could eliminate cofferdam	<ul style="list-style-type: none">• Would not be a smooth upstream face• Downstream face may get too steep	X
56	Use locking concrete tetrahedrons to replace/reinforce ramp	0	0	+1	+1	-2	<ul style="list-style-type: none">• More stable than independent rocks• Replace some of rock• Can batch and manufacture on site• Could be contractor option	<ul style="list-style-type: none">• Placement may be complex	X
57	Use the design/build contract process for the rock ramp component of the project	0	0	+1	0	-1	<ul style="list-style-type: none">• May reduce schedule	<ul style="list-style-type: none">• May add cost due to contractor risk	X
58	Increase number of screens to 16 for redundancy	0	+1	-1	-1	-1	<ul style="list-style-type: none">• Need redundancy• Could reduce loss of some larval fish during repairs without extra screen	<ul style="list-style-type: none">• Adds cost to project	P

Performance Attributes: Significant Improvement +2, +1, 0, -1, -2 Significant Degradation


Fish Performance (FP); Water Delivery Reliability (WDR); Engineering Design & Construction (EDC); Operations & Maintenance (OM); Cost Effectiveness (CE)

IDEA EVALUATION <i>Lower Yellowstone River Irrigation Dam, Fish Protection and Passage</i>									
Ideas		Performance Attributes					Advantages	DISADVANTAGES	PROPOSAL (P), Comment (C), BEING DONE (BD), OR REJECT (X)
No.	Description	FP	WDR	EDC	OM	CE			

59	In combination with a pumping plant, utilize an infiltration gallery						•	• Not practical as discussed earlier	X
60	Replace rock ramp with downstream bypass side channel (relocate river)	0	0	-2	-2	-2	<ul style="list-style-type: none"> • Fish do not need to traverse dam • Slope is flatter than ramp 	<ul style="list-style-type: none"> • High environmental impact • High cost • High degree of uncertainty of channel stability and need for rock riprap • Not likely permittable under 404 	C
61	Discuss constructibility of fish screens	0	0	+1	+1	+1	<ul style="list-style-type: none"> • Assure that we minimize construction issues 	• None apparent	C
62	Discuss constructibility of modified dam	0	0	+1	+1	+1	<ul style="list-style-type: none"> • Assure that we minimize construction issues 	• None apparent	C
63	Discuss the constructibility of the fish ramp	0	0	+1	+1	+1	<ul style="list-style-type: none"> • Assure that we minimize construction issues 	• None apparent	C


Performance Attributes: Significant Improvement +2, +1, 0, -1, -2 Significant Degradation

Fish Performance (FP); Water Delivery Reliability (WDR); Engineering Design & Construction (EDC); Operations & Maintenance (OM); Cost Effectiveness (CE)

IDEA EVALUATION <i>Lower Yellowstone River Irrigation Dam, Fish Protection and Passage</i>									
<i>Ideas</i>		Performance Attributes					Advantages	DISADVANTAGES	PROPOSAL (P), Comment (C), BEING DONE (BD), OR REJECT (X)
No.	Description	FP	WDR	EDC	OM	CE			
64	Make the initial half of ramp 300' wide and build in the dry on the south side of the existing dam	0	0	0	0	0	<ul style="list-style-type: none">• Build in dry• Better quality control	<ul style="list-style-type: none">• Would need to fill in portion of river not being used for ramp• Dam would be longer• Need to replace cable system for maintenance	P
65	Revisit V-screen design						<ul style="list-style-type: none">• 	<ul style="list-style-type: none">• May have fish stuck in forebay• Already eliminated from NEPA	X
66	Build an on-channel flat-plate screen and incorporate ice protection	0	+1	+1	+1	+1	<ul style="list-style-type: none">• Less likely to be damaged by debris• Easier to put trash rack in front• Not moving• Can be removed in winter• May not require as much depth of water• Common technology	<ul style="list-style-type: none">• May need longer headworks section to achieve screen area	P


Performance Attributes: Significant Improvement +2, +1, 0, -1, -2 Significant Degradation

Fish Performance (FP); Water Delivery Reliability (WDR); Engineering Design & Construction (EDC); Operations & Maintenance (OM); Cost Effectiveness (CE)

IDEA EVALUATION <i>Lower Yellowstone River Irrigation Dam, Fish Protection and Passage</i>									
Ideas		Performance Attributes					Advantages	DISADVANTAGES	PROPOSAL (P), Comment (C), BEING DONE (BD), OR REJECT (X)
No.	Description	FP	WDR	EDC	OM	CE			
67	Construct a flat-plate screen at Burns Creek (Mile 8)						<ul style="list-style-type: none"> Reduces amount of V-screen 	<ul style="list-style-type: none"> Need expensive trashrack End up with very long forebay BRT will be concerned about injuring adult fish if no trashrack 	X
68	Build rock ramp in the wet	-1	0	+1	-1	+2	<ul style="list-style-type: none"> Eliminate cofferdam 	<ul style="list-style-type: none"> May have quality control issues Would have seasonal restrictions 	X
69	Build ramp to ~90% complete in the wet and complete in low flow season	0	0	+1	0	+1	<ul style="list-style-type: none"> Eliminate cofferdam, could divert water around work area with geotubes or sand bags 	<ul style="list-style-type: none"> Would have seasonal restrictions Would need approval from DEQ and USFWS 	P
70	Investigate multiple sources for cylindrical screens						<ul style="list-style-type: none"> 	<ul style="list-style-type: none"> 	C w/6


Performance Attributes: Significant Improvement +2, +1, 0, -1, -2 Significant Degradation

Fish Performance (FP); Water Delivery Reliability (WDR); Engineering Design & Construction (EDC); Operations & Maintenance (OM); Cost Effectiveness (CE)

IDEA EVALUATION Lower Yellowstone River Irrigation Dam, Fish Protection and Passage									
<i>Ideas</i>		Performance Attributes					Advantages	DISADVANTAGES	PROPOSAL (P), Comment (C), BEING DONE (BD), OR REJECT (X)
No.	Description	FP	WDR	EDC	OM	CE			
71	Design trash racks for cylindrical screens	0	0	-1	0	-1	<ul style="list-style-type: none"> • Would be needed if screens are not robust enough to resist debris • Could accomplish be increasing number of bollards • Reduce O&M on screens 	<ul style="list-style-type: none"> • May need periodic cleaning • Need to accommodate ice forces • Could create ice jams 	C
72	Utilize a structure (diversion wall in place of dam) in the river to divert water to the intakes	-2	-2	0	-1	+2	<ul style="list-style-type: none"> • Would unblock portion of river for fish passage 	<ul style="list-style-type: none"> • Hard to control desired head at intake • Would need large diversion • May create a velocity barrier to fish 	X
73	Make space between trash racks and screens a long and narrow channel gated at upstream end to allow flushing of debris	-1	0	-1	-1	-2	<ul style="list-style-type: none"> • May sluice sediment from in front of screens 	<ul style="list-style-type: none"> • BRT would object to sluicing 	X


Performance Attributes: Significant Improvement +2, +1, 0, -1, -2 Significant Degradation

Fish Performance (FP); Water Delivery Reliability (WDR); Engineering Design & Construction (EDC); Operations & Maintenance (OM); Cost Effectiveness (CE)


IDEA EVALUATION <i>Lower Yellowstone River Irrigation Dam, Fish Protection and Passage</i>									
Ideas		Performance Attributes					Advantages	DISADVANTAGES	PROPOSAL (P), Comment (C), BEING DONE (BD), OR REJECT (X)
No.	Description	FP	WDR	EDC	OM	CE			

74	Use water jets to discourage fish entering canal						•	• Not practical	X
75	Add access road for front end loader to get to space between trash rack and screens						•	• Not practical for baseline design	X
76	Use bottom-mounted screens in lieu of circular screens	0	0	-2	-1	0	<ul style="list-style-type: none"> • Less depth of submergence needed • May be more tolerable to floating debris • Work well in shallow water applications 	<ul style="list-style-type: none"> • Need bigger footprint to get desired capacity • More difficult to remove • Ice may be a problem 	X
77	Electrify trash racks to repel fish						•	• Not practical	X
78	Use magnets to repel fish						•	• Not practical	X

Performance Attributes: Significant Improvement +2, +1, 0, -1, -2 Significant Degradation
Fish Performance (FP); Water Delivery Reliability (WDR); Engineering Design & Construction (EDC); Operations & Maintenance (OM); Cost Effectiveness (CE)


IDEA EVALUATION Lower Yellowstone River Irrigation Dam, Fish Protection and Passage									
Ideas		Performance Attributes					Advantages	DISADVANTAGES	PROPOSAL (P), Comment (C), BEING DONE (BD), OR REJECT (X)
No.	Description	FP	WDR	EDC	OM	CE			
79	Consider a siphon system to move water into irrigation canal						<ul style="list-style-type: none">•	<ul style="list-style-type: none">• Not practical	X
80	Set headworks back further to lessen amount of required cofferdam work	0	0	+1	0	+1	<ul style="list-style-type: none">• Could reduce cost and amount of cofferdams• Reduces susceptibility to debris	<ul style="list-style-type: none">• Concerned about accumulation of sediment• May have reduced sweeping velocity	P
81	Divert river into high flow channel during construction to allow work in the dry						<ul style="list-style-type: none">•	<ul style="list-style-type: none">• Construction season would be too short	X
82	Go to very flat rock ramp that we are certain will work	0	0	-1	-1	-2	<ul style="list-style-type: none">• Could accelerate work (but not on critical path)	<ul style="list-style-type: none">• More downstream impacts• BRT wants modeling regardless	X
83	Optimize top elevation of headworks	0	0	0	0	+1	<ul style="list-style-type: none">• Avoid building more than needed	<ul style="list-style-type: none">• None apparent	C

Performance Attributes: Significant Improvement +2, +1, 0, -1, -2 Significant Degradation
Fish Performance (FP); Water Delivery Reliability (WDR); Engineering Design & Construction (EDC); Operations & Maintenance (OM); Cost Effectiveness (CE)

IDEA EVALUATION Lower Yellowstone River Irrigation Dam, Fish Protection and Passage									
<i>Ideas</i>		Performance Attributes					Advantages	DISADVANTAGES	PROPOSAL (P), Comment (C), BEING DONE (BD), OR REJECT (X)
No.	Description	FP	WDR	EDC	OM	CE			
84	Build dam out of RCC	0	0	+1	0	+1	<ul style="list-style-type: none"> • Could build dam and ramp at same time (with final rock surface on ramp) • Rapid construction technique • May make No. 81 more feasible to allow construction in one season 	<ul style="list-style-type: none"> • Need specialty contractor • Need to stockpile materials in advance • Not preferred in cold weather • Need flat base pad to start • May end up with stepped upstream face 	C
85	Incorporate a spillway to minimize velocities on the ramp during high flow	+1	0	-1	0	-1	<ul style="list-style-type: none"> • Increases ramp stability for extreme events • Reduces overall river velocity during extreme events making fish passage better • Provide material for ramp 	<ul style="list-style-type: none"> • May lose some trees and change the riparian condition (need to mitigate) • Need to armour spillway 	C
86	Make side flood channel bigger to handle high flows						•	<ul style="list-style-type: none"> • High bedrock may make it difficult • Could permanently capture river 	X


Performance Attributes: Significant Improvement +2, +1, 0, -1, -2 Significant Degradation

Fish Performance (FP); Water Delivery Reliability (WDR); Engineering Design & Construction (EDC); Operations & Maintenance (OM); Cost Effectiveness (CE)

IDEA EVALUATION <i>Lower Yellowstone River Irrigation Dam, Fish Protection and Passage</i>									
Ideas		Performance Attributes					Advantages	DISADVANTAGES	PROPOSAL (P), Comment (C), BEING DONE (BD), OR REJECT (X)
No.	Description	FP	WDR	EDC	OM	CE			
87	Rehabilitate off-farm distribution system to reduce flow diversion	0	+1	0	0	-2	<ul style="list-style-type: none">• Reduce volume of water that needs to be diverted	<ul style="list-style-type: none">• Benefits may not be significant• May not be able to be accomplished in project timeline	X
88	Incorporate conservation measures in on-farm irrigation practices to reduce volume of water required	0	+1	0	0	-2	<ul style="list-style-type: none">• Reduce volume of water that needs to be diverted	<ul style="list-style-type: none">• Benefits may not be significant• May not be able to be accomplished in project timeline	X
89	Line existing dam with geomembrane or concrete filled mat to allow reuse	0	0	0	-1	+1	<ul style="list-style-type: none">• Lower cost solution	<ul style="list-style-type: none">• Would need to be anchored• Would bed rougher than propose weir• Less resistant to ice forces• Anchoring to unstable structure	X
90	Consider a non-uniform crest for the dam						<ul style="list-style-type: none">• 	<ul style="list-style-type: none">• 	BD


Performance Attributes: Significant Improvement +2, +1, 0, -1, -2 Significant Degradation

Fish Performance (FP); Water Delivery Reliability (WDR); Engineering Design & Construction (EDC); Operations & Maintenance (OM); Cost Effectiveness (CE)

IDEA EVALUATION <i>Lower Yellowstone River Irrigation Dam, Fish Protection and Passage</i>									
<i>Ideas</i>		Performance Attributes					Advantages	DISADVANTAGES	PROPOSAL (P), Comment (C), BEING DONE (BD), OR REJECT (X)
No.	Description	FP	WDR	EDC	OM	CE			
91	Consider on-farm measure to improve water quality						<ul style="list-style-type: none">	<ul style="list-style-type: none">Not a fish passage issue	X
92	Explore roughening the channel to increase the depth						<ul style="list-style-type: none">	<ul style="list-style-type: none">Not feasible	X
93	Gunite rock ramp for improved stability	0	0	-1	+1	-1	<ul style="list-style-type: none">Will help maintain stability, particularly at the surfaceIncreased confidence that low flow channel will not shift location or have rocks roll into it	<ul style="list-style-type: none">Could be subject to freeze thaw deterioration over timeAdded construction process and costLess naturalLess flexible for adaptive managementConcerned about uplift pressures	P
94	Vegetate the ramp						<ul style="list-style-type: none">	<ul style="list-style-type: none">Very difficultWould not last due to ice	X


Performance Attributes: Significant Improvement +2, +1, 0, -1, -2 Significant Degradation

Fish Performance (FP); Water Delivery Reliability (WDR); Engineering Design & Construction (EDC); Operations & Maintenance (OM); Cost Effectiveness (CE)

IDEA EVALUATION Lower Yellowstone River Irrigation Dam, Fish Protection and Passage									
<i>Ideas</i>		Performance Attributes					Advantages	DISADVANTAGES	PROPOSAL (P), Comment (C), BEING DONE (BD), OR REJECT (X)
No.	Description	FP	WDR	EDC	OM	CE			
95	Incorporate (concrete, sheet pile) sills in ramp for stability						•	•	C w/44
96	Ensure that the low flow channel within the ramp ties in with the natural thalweg at the toe of the ramp	+1	0	0	0	0	<ul style="list-style-type: none"> Fish follow thalweg, so improves passage continuity 	<ul style="list-style-type: none"> None apparent 	C
97	Vary width of the structure (dam and ramp) to control velocity	0	0	0	0	0	<ul style="list-style-type: none"> Altering width will alter velocity or depth, and can use this to stay within desired limits 	<ul style="list-style-type: none"> May impact flood plain 	C
98	Consider energy dissipaters at ramp toe to help control velocities	0	0	0	0	0	<ul style="list-style-type: none"> Could be a stilling basin or dissipater at the toe of ramp May be needed anyway 	<ul style="list-style-type: none"> Added component to project 	C
99	Use concrete bridge piers upstream to control ice						<ul style="list-style-type: none"> Break up ice before it goes over dam, or force it to go into floodplain 	<ul style="list-style-type: none"> Too much ice on river, so not feasible 	X

Performance Attributes: Significant Improvement +2, +1, 0, -1, -2 Significant Degradation


Fish Performance (FP); Water Delivery Reliability (WDR); Engineering Design & Construction (EDC); Operations & Maintenance (OM); Cost Effectiveness (CE)

IDEA EVALUATION									
Lower Yellowstone River Irrigation Dam, Fish Protection and Passage									
Ideas		Performance Attributes					Advantages	DISADVANTAGES	PROPOSAL (P), Comment (C), BEING DONE (BD), OR REJECT (X)
No.	Description	FP	WDR	EDC	OM	CE			

100	Do nothing – do not build project						•	• Non-compliant	X
101	Direct ice with structure to overflow flood channel on south side						• Break up ice and force it to go into floodplain	• Too much ice on river, so not feasible	X
102	Incorporate ice chute in face of dam to direct ice movement downstream						•	• Do not head differential to handle large volume of ice • Structure is too small • Not feasible	X
103	Build bridge over river above dam	0	0	-2	-2	-2	• Better access for maintenance • Enhance recreation	• Not a fish passage issue	X
104	Incorporate staging areas in the ramp for maintenance						• Preset platforms for maintenance equipment	• Not needed, surface can be traversed with a tracked vehicle	X
105	Consider alternate cleaning systems for screens						•	•	C w/6


Performance Attributes: Significant Improvement +2, +1, 0, -1, -2 Significant Degradation

Fish Performance (FP); Water Delivery Reliability (WDR); Engineering Design & Construction (EDC); Operations & Maintenance (OM); Cost Effectiveness (CE)

IDEA EVALUATION									
Lower Yellowstone River Irrigation Dam, Fish Protection and Passage									
Ideas		Performance Attributes					Advantages	DISADVANTAGES	PROPOSAL (P), Comment (C), BEING DONE (BD), OR REJECT (X)
No.	Description	FP	WDR	EDC	OM	CE			


106	Construct low flow channel in ramp out of concrete to fix location						•	•	P w/93
107	Use semi-submerged revolving drum screens	0	0	0	+1	-1	<ul style="list-style-type: none"> Self cleaning screens (back flushes itself) Does not have mechanical systems to maintain Easy to inspect for damage and maintenance since screen is partially exposed 	<ul style="list-style-type: none"> Lower range of allowable forebay Better suited for in-canal location where water surface variations are minimal Requires bigger footprint 	X
108	Incorporate fish guidance structure (e.g. bottom mounted curtain) to divert fish away from intake structure						•	<ul style="list-style-type: none"> May not be as survivable as a concrete wall Would need to be removed prior to freeze 	C w/20

Performance Attributes: Significant Improvement +2, +1, 0, -1, -2 Significant Degradation
Fish Performance (FP); Water Delivery Reliability (WDR); Engineering Design & Construction (EDC); Operations & Maintenance (OM); Cost Effectiveness (CE)

IDEA EVALUATION Lower Yellowstone River Irrigation Dam, Fish Protection and Passage									
<i>Ideas</i>		Performance Attributes					Advantages	DISADVANTAGES	PROPOSAL (P), Comment (C), BEING DONE (BD), OR REJECT (X)
No.	Description	FP	WDR	EDC	OM	CE			
109	Use crescent shaped rock ramp and minimize impacts to boat ramp						•	<ul style="list-style-type: none"> Not preferred by BRT May not provide desired 50% fish access Easier to relocate boat ramp 	X
110	Move boat ramp						• Required for mitigation	•	BD
111	Abandon boat ramp						• Being assessed as part of mitigation	•	BD
112	Install overshoot gates	-1	+1	0	+1	-1	<ul style="list-style-type: none"> Takes water off top profile reducing sediment and passage of larvae Would work with in-canal screen system 	<ul style="list-style-type: none"> Not preferred screen location Small risk of trapping an adult fish 	P
113	Construct a sluiceway						• Helps manage sediment	<ul style="list-style-type: none"> Very costly Not preferred by BRT 	X
114	Install pond upstream to trap sediments						•	• Not long term	X


Performance Attributes: Significant Improvement +2, +1, 0, -1, -2 Significant Degradation

Fish Performance (FP); Water Delivery Reliability (WDR); Engineering Design & Construction (EDC); Operations & Maintenance (OM); Cost Effectiveness (CE)

IDEA EVALUATION <i>Lower Yellowstone River Irrigation Dam, Fish Protection and Passage</i>									
Ideas		Performance Attributes					Advantages	DISADVANTAGES	PROPOSAL (P), Comment (C), BEING DONE (BD), OR REJECT (X)
No.	Description	FP	WDR	EDC	OM	CE			
115	Assure rock is a high durability material						<ul style="list-style-type: none">Proposing dolomite from ~400 miles awayLimestone available from ~250 miles away	<ul style="list-style-type: none">	BD
116	Stockpile extra rock for future maintenance	0	0	0	+1	-1	<ul style="list-style-type: none">Allows maintenance when needed without delays to obtain materialSupports adaptive managementCould be next to quarry or over filled in canal segment	<ul style="list-style-type: none">Volume of stockpile could be significant	C
117	Use embedded steel structural shapes to replace rock						<ul style="list-style-type: none">Option only if less costly than rockCan be installed in the wet	<ul style="list-style-type: none">DEQ does not like steel in riverNot naturalRecreation hazardTraps debrisDifficult to drive into existing rock	X
118	Consider a layered material system for ramp	0	0	0	-1	+1	<ul style="list-style-type: none">Current estimate considers only rock for 1% slope rampWould reduce costGood place to waste excess material	<ul style="list-style-type: none">Adaptive management may be more difficult	P

Performance Attributes: Significant Improvement +2, +1, 0, -1, -2 Significant Degradation


Fish Performance (FP); Water Delivery Reliability (WDR); Engineering Design & Construction (EDC); Operations & Maintenance (OM); Cost Effectiveness (CE)

IDEA EVALUATION <i>Lower Yellowstone River Irrigation Dam, Fish Protection and Passage</i>									
Ideas		Performance Attributes					Advantages	DISADVANTAGES	PROPOSAL (P), Comment (C), BEING DONE (BD), OR REJECT (X)
No.	Description	FP	WDR	EDC	OM	CE			

119	Use design/build for screens						<ul style="list-style-type: none"> Allow greater flexibility of screen selection 	<ul style="list-style-type: none"> Not normal procedure for screens 	C
120	Use multiple fabricators to build screens	0	0	+1	0	0	<ul style="list-style-type: none"> Help meets schedule 	<ul style="list-style-type: none"> More complex quality control 	C
121	Purchase-order screens and rock and inspect as government-supplied materials	0	0	0	0	0	<ul style="list-style-type: none"> Helps meet schedule Can obligate money by end of fiscal year Works OK with design/bid/build approach Could stockpile rock incase not available in future 	<ul style="list-style-type: none"> Could increase contractor claims 	C
122	Grout low flow channels traversing rock ramp						<ul style="list-style-type: none"> 	<ul style="list-style-type: none"> 	P w/93
123	Use submerged curtain downstream to keep fish out of (in the wet) construction zone	0	0	+1	0	0	<ul style="list-style-type: none"> Protects adult fish by keeping them out of construction zone May allow extending work into the migration season 	<ul style="list-style-type: none"> Added construction component 	C


Performance Attributes: Significant Improvement +2, +1, 0, -1, -2 Significant Degradation

Fish Performance (FP); Water Delivery Reliability (WDR); Engineering Design & Construction (EDC); Operations & Maintenance (OM); Cost Effectiveness (CE)

IDEA EVALUATION <i>Lower Yellowstone River Irrigation Dam, Fish Protection and Passage</i>									
<i>Ideas</i>		Performance Attributes					Advantages	DISADVANTAGES	PROPOSAL (P), Comment (C), BEING DONE (BD), OR REJECT (X)
No.	Description	FP	WDR	EDC	OM	CE			
124	Survey sand bar for least tern nesting						•	•	BD
125	Survey location of redds nests prior to construction to avoid disturbance						•	• Not feasible	X
126	Investigate alternate sources of suitable rock						•	•	BD
127	Reconsider concrete formed man-made rock	0	0	+1	+1	-2	<ul style="list-style-type: none"> • Viable for larger size boulders if natural stone of this size is unavailable • Could shape them to be more interlocking 	<ul style="list-style-type: none"> • Not as durable as natural stone • Tends to be more expensive than natural stone 	X
128	Build new dam/weir upstream and minimize demolition						<ul style="list-style-type: none"> • Works well with new headworks • Could serve as a cofferdam during construction of ramp 	•	BD

Performance Attributes: Significant Improvement +2, +1, 0, -1, -2 Significant Degradation

Fish Performance (FP); Water Delivery Reliability (WDR); Engineering Design & Construction (EDC); Operations & Maintenance (OM); Cost Effectiveness (CE)

IDEA EVALUATION <i>Lower Yellowstone River Irrigation Dam, Fish Protection and Passage</i>									
Ideas		Performance Attributes					Advantages	DISADVANTAGES	PROPOSAL (P), Comment (C), BEING DONE (BD), OR REJECT (X)
No.	Description	FP	WDR	EDC	OM	CE			
129	Explore use of rock from Montana Rail Link tunnel project west of Helena; and Montana DOT	0	0	0	0	+1	<ul style="list-style-type: none">• They have a large volume to dispose of• On a railroad line	<ul style="list-style-type: none">• Over 500 miles away• Depends on size of material and wuality	C
130	Allow fieldstone on lower layer of the rock ramp						<ul style="list-style-type: none">• Protected by quarry stone• Locally available• Low cost material	<ul style="list-style-type: none">•	P w/118

Performance Attributes: Significant Improvement +2, +1, 0, -1, -2 Significant Degradation
Fish Performance (FP); Water Delivery Reliability (WDR); Engineering Design & Construction (EDC); Operations & Maintenance (OM); Cost Effectiveness (CE)

CONTACT DIRECTORY AND ATTENDANCE

VALUE ENGINEERING TEAM STUDY

APPENDIX E: CONTACT DIRECTORY & VE STUDY TEAM MEMBERS

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